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ABSTRACT

Provided are 23 course syllabi representing a broad range of courses taught in the fields of history of technology and technological studies. The collection falls into two major categories. The first section outlines courses dealing primarily with the history of technology, including courses dealing with the history of technology in a Western or world context, specifically an American context, and in various topical contexts. (Examples of these topics are flight, invention and innovation, and women in technology.) The second section is concerned with contemporary technological studies. It contains courses which introduce students to the area of science and technology studies, courses designed to provide "technological literacy" to liberal arts students, and courses focusing on specific topics in modern technology (such as gender, the environment, the impact of television, and nuclear proliferation). Each syllabus contains: (1) a statement of course goals; (2) subjects covered; (3) required and/or suggested readings; and (4) study and examination questions. The appendix includes a list of over 100 additional courses, each of which is briefly annotated. (TW)

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THE MACHINE IN THE UNIVERSITY:

SAMPLE COURSE SYLLABI FOR THE HISTORY OF TECHNOLOGY AND TECHNOLOGY STUDIES

Second Edition

Compiled and Edited by Terry S. Reynolds
and
The Technology Studies and Education Committee
for The Society for the History of Technology

in Cooperation with the Michigan Technological University and
Lehigh University Science, Technology and Society Programs

2

THE MACHINE IN THE UNIVERSITY
Sample Course Syllabi for the History of Technology and Technology Studies

(2nd Edition)

Compiled and Edited by
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INTRODUCTION TO THE SECOND EDITION

The Society for the History of Technology has long recognized the importance of the educational side of the discipline of the history of technology. This recognition led in the mid-1970s to the establishment of a special division, Technology Studies and Education (TS&E), focused on issues related to teaching the history of technology and the more inclusive field of technology studies. TS&E early sponsored several activities within the Society for the History of Technology, most notably a number of educationally-oriented programs at the Society's annual meetings. In the fall of 1981, however, TS&E's Steering Committee voted to expand the domain of the division's activities by seeking to collect and publish selected representative course syllabi in both the history of technology and in technology studies. Such a collection, the Committee hoped, would prove an important resource for college and university teachers interested in developing or improving technology-oriented courses. The result of that project was the first edition of the present work, which appeared in mid-1983 under the sponsorship of the Technology Studies and Education Division, with chief editorial responsibilities carried out by Stephen H. Cutcliffe of Lehigh University.

The Machine in the University filled a real need in the discipline, for by the fall of 1985, when the Society for the History of Technology held its annual meeting, the first printing was nearly sold out. When the Steering Committee of the Technology Studies and Education group met then, the Committee, pleased by the success of its first publication foray, voted to compile a new edition.

Despite a warning from Stephen Cutcliffe, the editor of the first edition of **The Machine in the University,** that I was letting myself in for more than I realized, I volunteered to undertake the task of editing the new volume, with members of the TS&E Steering Committee serving as the "Screening Committee" for submissions.

Late in 1985 and early in 1986, the Committee sent out a call for course syllabi. That call was published in a number of newsletters, including, among others, those of the Society for the History of Technology, the Society for Philosophy and Technology, and the Society for Literature and Science, Lehigh's **Science, Technology, & Society Newsletter**, and the **New Liberal Arts Newsletter**. Moreover, since a number of new courses dealing with technology had been emerging as part of the Sloan "New Liberal Arts" (NLA) program, the Committee also sent copies of the call for submissions to approximately 75 people involved in the development of NLA technology-related courses.

Altogether, I received syllabi for over forty courses dealing with the history of technology and technology studies. These submissions were augmented by adding a selection of quality syllabi published in the previous three years' issues of the

Science, Technology, & Society Newsletter and the **Bulletin of Science, Technology, and Society**. Approximately fifty syllabi were ultimately reviewed by the Screening Committee for inclusion in a second edition of **The Machine in the University**. From this group twenty-three were selected.

The screening process was extremely difficult, since few poor syllabi were submitted. In making selections for inclusion, the Committee used a variety of criteria. One criterion was potential utility to instructors preparing new courses or revising old ones. Thus syllabi which provided access to a wide variety of reading matter tended to be preferred to those which utilized only one or two standard, well-known textbooks. Another was broad coverage. If several syllabi covered approximately the same materials with similar approaches, only one was published, even if all were excellent. The space saved was used to publish syllabi in different areas or syllabi with different approaches. The Committee also tended to favor submissions which included sample exams and study questions, since such attachments provided a clearer indication, than lecture topics and reading assignments alone, of what instructors saw as the key issues and what they expected students to absorb.

Because space limitations meant we could not reproduce all syllabi and because we wished to insure that none of the courses which could not be included would be lost to those who might wish to make use of them, the present edition, following the example of the first edition, includes as an appendix a briefly-annotated list of courses and individuals, the syllabi for which were not reproduced in their entirety. Presumably each of these individuals would be willing to share his or her ideas and materials with those desirous of further information. Contact should be made directly with the individual rather than though the TS&E Committee.

Despite some similarities, the present edition differs considerably from the first edition in content. First, only three of the twenty-three syllabi included in this volume have been carried over from the earlier edition--Richard Hirsh's three-term history of Western technology sequence, John Staudenmaier's history of American technology, and Daryl Hafter's historically-oriented course on "Technology, Social Change and the Role of Women". And even these have been updated and augmented. Second, while the section dealing with syllabi in the history of technology is somewhat smaller in this edition, the section containing syllabi focusing on general technology studies is larger. This development is largely a reflection of the comparative volume of submissions. Fewer faculty teaching history of technology courses submitted syllabi this time; many more faculty teaching in the area of contemporary technology studies did.

The present edition should be seen as supplementing, not displacing, the first edition, which, unfortunately, is out of print. Some course types and areas that appeared in the first edition do not appear in the present edition, for example an honors sequence course in the history of technology and topical courses dealing with technology and ethics, technology and the city, and the impact of the automobile. Moreover, the first edition also contains course development ideas and organizing themes worth investigating, although the readings cited may be somewhat dated.

The twenty-three courses reproduced in this collection fall into two major categories: (1) technology in history and (2) technology in the contemporary world. The first category includes courses dealing primarily with the history of

technology; the second courses dealing largely with issues relating to contemporary technology. In the section on technology in history, we have included courses dealing with the history of technology in a Western or world context, in a specifically American context, and in various topical contexts (e.g., flight, invention and innovation, women). In the section on contemporary technology studies we have included courses which introduce students to the area of Science and Technology Studies, courses designed to provide "technology literacy" to liberal arts students, and courses focusing on specific topics in modern technology (for example, gender, the environment, the impact of television, and nuclear proliferation).

While the syllabi contained in this volume and in the earlier edition provide suggestions for both student and faculty reading, there is obviously much additional material for educators to draw on. The fields of history of technology and technology studies are covered by several bibliographical guides that may aid those developing courses. Among the most useful for the history of technology are Eugene Ferguson's standard **Bibliography of the History of Technology** (Cambridge, Mass.: MIT Press, 1968) and Marc Rothenberg's **The History of Science and Technology in the United States: A Critical and Selective Bibliography** (New York: Garland, 1982). In addition, Garland Publishing company has begun publishing a series of annotated bibliographies in the histories of specific sciences and technologies. The entire set has not yet appeared, but volumes for the history of chemical technology, the history of civil engineering, and the history of mining and metallurgy, to name just three, have. Finally, the Society for the History of Technology's annual bibliography, published in the April issue of its journal **Technology and Culture**, should be consulted for continually updated bibliographical information. Two bibliographical works of some importance that cover the broader area of technology studies, as well as the history of technology, are Paul Durbin's **A Guide to the Culture of Science, Technology, and Medicine**, 2nd ed., (New York: Free Press, 1984) and Stephen Cutcliffe, Judith Mistichelli, and Christine Roysdon's **Technology and Values in American Civilization: A Guide to Information Sources** (Detroit: Gale Research Co., 1980). Finally, the **Bulletin of Science, Technology, and Society**, the **Science, Technology, and Society Newsletter**, and the **NLA Newsletter** periodically print course syllabi and notices of new publications in the broad area of technology studies, as well as the more specific area of history of technology.

In compiling this volume I have incurred a number of debts. First, thanks are due to those instructors who took the time to submit their course materials, and especially to those who further modified their syllabi after I requested additional information or clarification. Second, thanks go to the members of the TS&E Steering Committee. Those on that committee (named below) served with me as the Screening Committee for the present work. When the time came to review submissions, all members of the committee responded and several provided additional helpful suggestions. All in all, they made the very difficult task of final selection considerably easier. I owe, in addition, a special thanks to Stephen H. Cutcliffe, a member of the Screening Committee and editor of the first edition of **The Machine in the University**. Steve, after warning me that the project was much harder than it looked, had sufficient compassion to make the undertaking much easier than it would otherwise have been. He reviewed several drafts of the present work, and I have relied very heavily on his advice, editorial and otherwise, throughout the project. This work is certainly much better because of his assistance. On the local level, the work was supported by the Science,

Technology, and Society Program of Michigan Technological University. Among those associated with that Program to whom I owe thanks are Larry Lankton, Bruce Seely, and Mark Rose. All three provided assistance in various forms--encouragement, missing references, sympathy, suggestions, and so on. Thanks are also due Annette C. Coburn, who shared with me the task of entering the original data on word processor and running off final copy. Finally, I would like to acknowledge the work of Mary Jo Carlen of Lehigh University's STS Program, who helped proofread the manuscript and prepare the cover, and who will be playing a central role in the distribution of this volume. Any errors that have occurred in this compilation are, unfortunately, my responsibility, much as I would like to pass them off to anyone else handy. And I would, of course, appreciate it if those discovering errors would bring them to my attention.

Terry S. Reynolds (Michigan Technological University)
Publications Project Chair
Technology Studies and Education Committee
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SECTION I: TECHNOLOGY IN HISTORY

Part 1: Technology in World History

HISTORY OF TECHNOLOGY
FROM PREHISTORY TO THE INDUSTRIAL REVOLUTION

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INTRODUCTION

Modern society can be characterized by technological achievements and their ill-considered side effects. These include powerful machines, grandiose architectural masterpieces, and efficient factories on the one hand and environmental pollution, energy shortages, and labor unrest on the other. But these elements of society are really not such recent developments. Hundreds of years ago, societies that produced new inventions and engineering techniques also faced challenges concerning how to use them more effectively. Like us today, our ancestors were not always successful in meeting these challenges.

In this course, we will examine the history of technology from prehistoric times to the onset of the industrial revolution in the 17th century. Besides looking at technological accomplishments, we will also consider their impact on different societies. Since many responses to technology have not changed much since ancient times, a study of the development of early technologies may give us insights into recent achievements and their effects on modern life.

This is the first of a three-quarter sequence in the history of technology. In the winter, we will offer History of Technology 4212, which concerns the history of the industrial revolution from 1700 to 1900. The spring course, History of Technology 4213, will deal with the history of modern technology in America from 1900 through 1987. [The syllabi for these courses are printed following this one, Editor]

COURSE REQUIREMENTS

Participation in classes, one short paper, one mid-term examination, and a final examination. Grades will be assigned on the basis of the following approximate formula and a modified bell curve:

Mid-term exams:	30%
Paper:	20%
Final Exam:	30%
Class Participation:	20%

For the paper, I will ask you to choose an invention and discuss how and why it was invented. What was its use, and what impact did it have on society? The paper should be 2-3 typed pages, with references listed. It is due the twelfth class period. [For details on the paper see page 46, Editor]

REQUIRED READING

Jean Gimpel, **The Medieval Machine** (New York: Holt, Rinehart, and Winston, 1976) and other short articles (listed below).

COURSE SCHEDULE

[This quarter-length course meets bi-weekly, Editor]

1. Course Introduction

ANCIENT TECHNOLOGY

2. Prehistoric Technology and the Agricultural Revolution
   Sherwood L. Washburn, "Tools and Human Evolution," **Scientific American** 203 (Sept. 1960): 62-75.
   Peter F. Drucker, "The First Technological Revolution and Its Lessons," **Technology and Culture** 7 (Spring 1966): 143-151.

3. Technology in the River Valley Civilizations
   Fred Wendorf, Romuald Schild, and Angela E. Close, "An Ancient Harvest on the Nile," **Science 82** 3 (Nov. 1982): 68-73.

4. Craft Technology in Antiquity
   V. G. Childe, **Man Makes Himself** (New York: New American Library, 1951), pp. 75-81 ("The Neolithic Revolution").

5. Craft Technology, continued, and Film
   Film: **The Hidden Structure**, from the J. Bronowski, "Ascent of Man" series.
   Robert Madden, James D. Muhly, and Tamara S. Wheeler, "How the Iron Age Began," **Scientific American** 237 (Oct. 1977): 122-131.

6. Technology in Classical Greece and Rome
   R. J. Forbes, **Man the Maker** (New York: Henry Schuman, 1950), pp. 60-88 ("Greeks and Romans").
   J. G. Landels, **Engineering in the Ancient World** (London: Chatto and Windus, 1978), pp. 9-33 ("Power and Energy Sources").

7. Technology in Classical Greece and Rome, continued
   Norman Smith, "Roman Hydraulic Technology," **Scientific American** 238 (May 1978): 154-161.
   Vernard Foley and Werner Soedel, "Ancient Oared Warships," **Scientific American** 244 (April 1981): 148-163.

8. The "Failure" of Ancient Technology
   Lynn White, **The Dynamo and Virgin Reconsidered** (Cambridge, Mass.: MIT Press, 1968), pp. 75-95 ("The Historical Roots of Our Ecologic Crisis").

9. MID-TERM EXAMINATION

MEDIEVAL TECHNOLOGY

10. The Energy Revolution
    Gimpel, **Medieval Machine**, ch. 1 and 4, pp. 1-28 and 75-92.

11. The Agricultural Revolution
Gimpel, **Medieval Machine**, ch. 2-3, pp. 29-74.

12. Military Technology
P. Young, **The Machinery of War** (London: Hart Davis, 1973), pp. 29-41, 54-57 ("The Dark and Middle Ages").
PAPER DUE TODAY.

13. Clocks and Culture
Gimpel, **Medieval Machine**, ch. 7, pp. 147-170.

14. The Printing Press
D. S. L. Cardwell, **Turning Points in Western Technology** (New York: Science History, 1972), pp. 19-29 ("The Printing Press").

15. Metals & Mining
Arnold Pacey, **The Maze of Ingenuity** (Cambridge, Mass.: MIT Press, 1976), pp. 144-163 ("Social Ideals in Technical Change").

16. The "Success" of Medieval Technology
Lionel Casson, "Godliness and Work," **Science 81** 2 (Sept. 1981): 36-43.

ORIGINS OF MODERN TECHNOLOGY

17. A New Intellectual Framework for Technology
Gimpel, **Medieval Machine**, ch. 8-9, and Epilogue, pp. 171-252.

18. The Mechanical Philosophy and Discovery of the Atmosphere
Cardwell, **Turning Points**, pp. 46-59 ("The Scientific Revolution and the Progress of Technology").

19. Early Steam Technology
Cardwell, **Turning Points**, pp. 66-72 ("Newcomen and the Fire Engine").

20. Conclusion

21. FINAL EXAMINATION (No changes except with Dean's permission).

QUESTIONS TO GUIDE READINGS

Washburn, "Tools and Human Evolution."
1. How have tools affected the evolution of humankind?
2. What is the significance of bipedalism?
3. What was the importance of "self-domestication"?

Drucker, "The First Technological Revolution and Its Lessons."
1. Why was the age of irrigation civilization an age of technological innovation?
2. When and why did the individual "emerge"?

Wendorf, et al., "An Ancient Harvest on the Nile."
1. What are the old assumptions about the origin of agriculture?
2. How did the research described in the article challenge the traditional views of the origin of agriculture?

3. How did the article define "domestication," and what is the heretical view of domestication?

Childe, **Man Makes Himself**, excerpt.
1. Describe some neolithic industries.
2. What devices were used for textile making?

Maddin, "How the Iron Age Began."
1. How, why, and when did iron replace bronze?
2. Describe the steps in making iron and steel? What are the advantages and disadvantages of steel?
3. What is quenching?

Forbes, "Greeks and Romans," excerpt.
1. How much and what kind of machinery existed in classical societies?
2. How extensively were power machines used? Why?
3. Describe Roman communications and transportation technologies.
4. What is a war engine?

Landels, **Engineering in the Ancient World**, excerpt.
1. What kinds of power sources were used in classical antiquity for different jobs?
2. Describe different types of water wheels and their advantages.
3. How much were wind and steam sources used? Why?

Smith, "Roman Hydraulic Technology."
1. Why did the Romans build aqueducts?
2. What special techniques and materials did they use?
3. How sophisticated was Roman hydraulic technology? Did others emulate it?

Foley and Soedel, "Ancient Oared Warships."
1. Describe the evolution of the trireme.
2. What were some of the sophisticated design techniques used by the Greeks in building ships?
3. What scientific principles did the Greeks consciously employ?

White, "The Historical Roots of Our Ecologic Crisis."
1. Give a few examples of ecologic crises in the Middle Ages.
2. Why was Portugal a symbol of technological superiority?
3. What occurred around 830 A.D. in humankind's attitude toward nature? How did Christianity affect the way people dealt with their environment?

Young, **The Machinery of War**, chapter, "The Dark and Middle Ages."
1. What happened to the military arts after the fall of the Roman empire?
2. What was the answer to the power of heavy cavalry?
3. What was the significance of the Swiss pike phalanx?
4. Describe offensive and defensive tactics of siegecraft.

Cardwell excerpt, "The Scientific Revolution."
1. What is meant by the "century of genius"? What occurred during this century?
2. How did a philosophy of nature affect scientific developments? Describe the philosophy.
3. What is meant by the "discovery of the atmosphere"?

Cardwell excerpt, "Newcomen and the Fire Engine."

1. Why would Bacon have been delighted with Newcomen's invention?
2. What are the main features of the Newcomen engine?
3. What were the motivations of Savery and Newcomen in inventing their steam engines?

Pacey, "Social Ideals in Technical Change."

1. In what terms should we understand the rapid development of mining between 1450 and 1630, according to Pacey?
2. What was the demand for mined metals?
3. What was the role of bankers in developing new mines and techniques?
4. Who was Agricola and what were his theories on the social status of mining? Why was his view important?

Casson, "Godliness and Work."

1. How much did the Romans and Greeks exploit mechanical power?
2. How detrimental was slavery to technological innovation in the Roman Era? In the Middle Ages?
3. What prejudices did the Greeks and Romans have concerning work?
4. What impact did Christianity have on technological innovation?

Gimpel, **Medieval Machine.**

1. What were some of the major features accompanying the first industrial revolution? What makes them so remarkable?
2. Why were monasteries significant in the history of medieval technology?
3. What are the contents of the Domesday report?
4. What does the use of tidal mills represent?
5. What impact did the climate have on medieval agriculture?
6. What allowed horses to pull 6,400 kg?
7. What was the symbiotic relationship between horses and the medieval agricultural system?
8. What were the consequences of the heavy plow?
9. Describe the medieval diet.
10. Why was stone quarrying the most important mining industry in medieval Europe?
11. What was the significance of waterpower to the iron industry?
12. How and why did European industrialism play havoc on the environment? Provide examples.
13. Why were royal forests created?
14. What antipollution measures were taken in the Middle Ages?
15. Why did medieval society believe in progress?
16. What were the consequences of clocks striking equinoctial hours?
17. What important step did Charles V take?
18. What did the "rational outlook of life" refer to?
19. What important contributions did the Arabs make to Western science?
20. What did Roger Bacon do for experimental science?
21. What effects, positive and negative, did the Black Death have?
22. What comparisons does Gimpel make between the Middle Ages and recent history?

MIDTERM EXAMINATION INFORMATION

You will be asked to write an essay on one of the following three essay questions. Only at the time of the test will you find out which one will be included. To prepare, you may want to make outlines of your arguments and fill them in with

details and examples from your readings and class notes. However, you may not use the outline during the exam. It is a closed book test. The essay will be worth between 25% and 40% of the test grade. There will also be a short answer section and a multiple choice section on the exam.

Possible Essay Questions

I. Describe two agricultural innovations used by each of the following people:

* Prehistoric man (before 3500 BC)
* The Egyptian and Mesopotamian peoples

Be sure to offer enough detail to demonstrate your understanding of the innovations. Then analyze the importance of each innovation on the social development of their civilizations. In other words, what new social structures evolved as a result of these technological developments.

II. Peter Drucker writes in his article, "The First Technological Revolution and Its Lessons," that if an educated man of the first technological revolution were transported magically to the present time, he would be able to cope with most aspects of modern civilization. Explain what Drucker means by the "First Technological Revolution" and explain why his assertion might be true. Give specific examples relating to social, economic, and various technological systems that were developed by 1000 BC and which are still common today.

III. Three major ancient civilizations that we have discussed are those of the Egyptians, Mesopotamians, and Greeks/Romans. Each one had distinctive technologies that were developed as a result of different forces and were used for different purposes. In this essay, you should:

Analyze the different reasons for the development of the technologies in each civilization. In other words, how did the technologies emerge as they did, and what were the primary goals of the people who developed them?

Give one major example of each civilization's technology and describe why and how it was developed? What were their uses? What social impact did they have?

* * * * * * * * * * * * * * * *

For all these essays, be sure to provide specific examples and clear arguments. You will be penalized for general, unsubstantiated arguments.

MID-TERM EXAMINATION

PART I. MULTIPLE CHOICE: In the following multiple choice questions, there are one or two correct answers. Circle the correct answer(s) and write it (them) on your answer sheet. Parts I and II of this exam are worth 70 points. [Correct answers are circled, Editor]

1. Which of the following names are/is associated with Roman water delivery systems? A) Djer; B) Heron (or Hero); (C) Frontinus; (D) Aqua Appia; E) Aquamarine.

2. Hammurabi's code was important historically because: A) It was a set of laws concerning irrigation in ancient Egypt; B) It provided instructions for building pyramids; (C) It was the earliest known written legal framework; D) It instructed craftsmen on how to build kilns and potter's wheels; E) It was the earliest known method of signaling over long distances.

3. Activities known to have occurred in the Fertile Crescent included: A) Greek temple building; (B) Neolithic stockbreeding and farming; C) Inca temple building; D) Mesopotamian cultivation of the Nile River; E) Production of textiles in factories.

4. Ancient textile manufacturing was associated with which of the following: A) It used spinning wheels; B) It led quickly to mass production; C) It used expensive equipment comparable to that employed in pottery making; (D) It was a cottage industry; E) None.

5. The form of steam engine invented by a Greek: A) could have been a practical power source; B) was more typical of Roman technological innovations; (C) was only an elegant plaything; D) led directly to Savery's work on another steam engine in the 1600s; E) was useful in developing London's water system in the 1800s.

6. Among the special techniques or devices used in Roman hydraulic technology was/were: A) the aqua appia; (B) the chain of pots; C) the shaduf; D) the steam pump; (E) the siphon.

7. The nucleus was: A) part of a Greek temple; B) a war "engine"; (C) part of a Roman road; D) an architectural device used by the Romans and Greeks; E) a combination of protons and neutrons, as hypothesized by the ancient Greek inventor of atomic theory, Democritus.

8. Among the steps in making pottery was/were: A) collating; B) fulling; C) carding; (D) forming; E) none.

9. Techniques used to make iron harder included: A) bronzing; B) oxidizing; (C) carburizing; D) spinning; (E) quenching.

10. Among the Greeks' inventions was/were: A) concrete; B) the semicircular arch; (C) the trireme; D) the kiln; E) the ziggurat.

11. The "failure" of ancient technology had many causes, among which was/were: A) the abolition of mining by Romans; (B) the rise of Christianity; (C) little concern for the environment; D) the decline of Christianity; E) no knowledge of exploiting mechanical power for industrial uses.

12. People performing work in technology and science: A) share the same goals; B) have always employed similar quantitative methods; C) have interacted constantly throughout history; D) have always been well educated in schools; (E) none.

PART II. FILL-INS: In the following sentences, missing words are represented by blanks. On the answer sheet, write precise and concise answers that correspond to these blanks. Except for 14 and 16, all can be answered in one or two words. [Correct answers are placed in the blanks, Editor]

13. Without man evolving into a (bipedal) animal, it is unlikely he would have become a maker of (tools [or technology]).

14. What evidence from the 9th century A.D. do historians have suggesting that humankind's attitude toward nature had changed since ancient times? (calendar showing "dirty" work).

15. Neolithic (pottery) making had great significance for human thought and for the beginning of science.

16. Bronze was sometimes a better material to work with than "bloomery" iron for several reasons. One is (harder; higher tensile strength; melts at lower temperatures; suited to casting).

17. Greek scientists who had great capacity for developing machinery included (Hero/Heron) and (Archimedes) [Ctesibius, etc.].

18. The definition of "technology" generally includes three components. They are (hardware), (organization), and (knowledge). [any order]

19. The cooking of food led to several other technologies. Two of them were (pottery, food preparation) and (metallurgy, beer brewing). [any two]

20. (Imhotep) was the first engineer known by name to history. (Joser) was his king, for whom a pyramid was constructed.

21. The Egyptian pharaohs found that knowledge of when the Nile floods would arrive gave them extra power in governing their people. Two technical devices that provided them with this knowledge were (Nilometer) and (calendar).

22. An example of a composite tool is the (sickle, spear, axe, hammer, etc.).

PART III. ESSAY: (30 points) Be sure to provide specific examples and a complete analysis, not just a recitation of unrelated facts.

> Peter Drucker writes in his article, "The First Technological Revolution and Its Lessons," that if an educated man of the first technological revolution were transported magically to the present time, he would be able to cope with most aspects of modern civilization. Explain what Drucker means by the "First Technological Revolution," and explain why his assertion might be true. Give specific examples relating to social, economic, and various technological systems that were developed by 1000 B.C. and which are still common today.

(Essay Question Grading Guidelines)

A. (7 pts.) The student must identify what is meant by the "First Technological Revolution." It is a revolution based on irrigation-type agriculture.

B. (8 pts.) The "magically transported" person would be able to cope with most aspects of modern civilization because settled agriculture led to the basic work specialization, economic system, bureaucratic [government] system, and social relationships that we still have today.

C. (15 pts.) Specific Examples [5 pts. possible for each category; one example in each of the categories = 3 pts.; two examples = 5 pts.]
*Social: government bureaucracy, class differentiation
*Economic: money economy, town market
*Technological: architecture, metallurgy, pottery [big industry]
I want to see <u>at least</u> these three components.

FINAL EXAMINATION INFORMATION

You will be asked to write an essay on <u>one</u> of the following three essay questions. At the time of the test, I will tell you which one to write on. To prepare for it, you may want to make outlines of your arguments and fill them in with details and examples from your reading and class notes. However, you may <u>NOT</u> use the outline during the exam. It is a closed book test. The essay will be worth between 30% and 40% of the test grade. There may also be a short answer section and possibly a multiple choice section on the exam.

<u>Possible Essay Questions</u>

I. The subtitle of Jean Gimpel's book, **The Medieval Machine**, is "The Industrial Revolution of the Middle Ages." In this essay, I want you to justify Gimpel's thesis that an Industrial Revolution did indeed occur during the middle ages. To write the essay, consider first the major changes that occurred between about 400 AD and 1715 AD. Then demonstrate how these led to a new technological order based on machines and processes that would relieve man's burden and increase his standard of living. Make sure you also explain why the revolution occurred in the Middle Ages and not earlier. Use specific examples from class notes, readings, and outside research.

II. Lewis Mumford characterizes the period of technology between roughly 200 AD and 1750 AD as a "wood and water" complex. In other words, wood and water were the primary materials used in many forms for Western technology in this period. While I think that this description is generally correct, what I would like you to do is to <u>attack</u> this generalization. That is, write an essay in which you argue that Mumford's "wood and water" generalization does <u>not</u> hold. Use specific examples of machines or processes that support your argument. Of course, be sure also to point out instances in which the generalization is correct.

III. According to Lynn White,

> "The chief glory of the Middle Ages was not its cathedrals, it epics, its vast structures of scholastic philosophy; it was the building for the first time in history of a complex civilization which was upheld not on the sinews of sweating slaves and coolies but primarily by non-human power."

In what ways do you agree or disagree with this statement? Write a well-integrated essay on this theme (with your modifications) covering the period from about 400 AD to 1750 AD.

FINAL EXAMINATION

PART I. MULTIPLE CHOICE: In the following multiple choice questions, there are one or two correct answers. Circle the correct answer(s) and write it (them) on your answer sheet.

1. Technology in the Middle Ages can be characterized by which of the following statements? a) There was a climate of opinion that rejected the use of power machines; (b) Investment capital for industrial endeavors was raised more efficiently than in ancient times; (c) Workmen's wages tended to increase during much of the Middle Ages; d) Windmills exploited water power extensively; e) There was little continuity between developments in medieval technology and modern (17th and 18th century) technology.

2. The development of the Newcomen steam engine (1712) was affected by which of the following? a) The abrupt and unexpected failure of over half the water wheels in England during a drought; b) The rediscovery of ancient Greek classical works on technology; (c) The existence and publicity surrounding the "Miner's Friend"; d) The need to pump water from surface level (strip) mines; e) The introduction of steam locomotives.

3. The technological supremacy of the West over the East (Byzantium) can be explained partly by a) the East's supremacy in commerce, political stability, and level of education; b) the West's leadership in science; (c) repeated invasions of the West by outsiders; d) the lack of typewriters in the East and the slow spread of learning; (e) the Western victory of Christianity over paganism.

4. Which of the following have something to do with waterwheels? a) Archimedes; b) Buccalentus; (c) Vitruvius; d) Norsius; (e) tidal mills.

5. The use of inorganic sources of energy in the Middle Ages a) led farmers away from the use of horses; b) resulted partly from the success of alchemists in improving energy outputs of fuels; c) became widespread in the middle eastern countries of Islam and Byzantium; (d) contributed to the attitude that the use of machines was a good thing; e) encouraged the transition to coal and oil as primary fuel sources.

6. The agricultural revolution of the Middle Ages can be described by which of the following statements? (a) The revolution was affected by a warmer and drier climate between about 750 and 1200 AD; b) New plows were introduced to till the dry soil of the Mediterranean lands; c) New collars were introduced that enabled oxen to perform more work; d) the four-field system of crop rotation was introduced; e) Waterwheels were used extensively for irrigation purposes.

7. The new plow of the Middle Ages (a) led to a more communal behavior by peasants; b) was made entirely of hard, flexible wood; c) made it possible for the first time to use light, dry soil for agriculture; d) was preferably pulled by oxen; e) changed the shapes of fields.

8. The origins of experimental science in the 13th century has been associated with a) Edward of Thierry; (b) Roger Bacon; c) Francis Bacon; d) Francis the Mule; e) Euclid.

9. The discovery of the atmosphere had several consequences, among which was (were): (a) an emerging science of meteorology; (b) aeronautical studies; c) invention of printing; d) invention of water pumps; e) coal mining in England.

10. The Newcomen "fire" engine was successful because a) it put out accidental fires in mines; (b) it had a separate boiler cylinder; c) it was as safe as the Savery machine but was much cheaper to build; d) it could be and was used inside coal mines (underground); e) its efficiency was improved by the scientific engineer, Galileo.

PART II. FILL-INS. In the following sentences, missing words are represented by blanks. On the answer sheet, write your precise and concise answers that correspond to these blanks. Most can be answered in a few words. [Correct answers are placed in the blanks, Editor]

11. At the level of the common man, anthropocentric Christianity made it possible to do what? (exploit natural resources; mine)

12. Compared to Roman times, the state of military arts in Europe in the early middle ages was (backwards; undisciplined). (Shock, armored) weapons were more useful than missiles. The first sign of change was instigated by (Charlemagne; Charles Martel also accepted), the Frankish ruler, in about 800 AD.

13. Gutenberg was successful in designing a printing press because of his ability to solve two technical problems. What were they? (Finding a way to make stamps of equal length and finding a way to make stamps of equal thickness and use of ink that didn't glob up, or use of cheap paper)

14. Two examples of technologies that the ancient Greeks and Romans knew about but did not exploit were (wind power , water power, and steam power). [any two]

15. The earliest known national anti-pollution laws were passed in (England) in the late 14th century concerning pollution of the (water) and (air).

16. According to Gimpel's comparison of trends in the Middle Ages and in recent history, the United States is currently in an era of (maturity, or steady state) and will soon enter an era of (decline, or old age).

17. Name one person who designed pendulum clocks in the 17th century. (Galileo, or Huygens)

18. How has a famous historian categorized the medieval diet? ("full of beans")

19. What did another historian call "the key machine of the modern industrial age"? (the clock)

20. How did the Black Death improve the standard of living? (By adding to the wealth of those who survived through inheritance; reduced crowding and overpopulation)

PART III. ESSAY:

Lewis Mumford characterizes the period of technology between roughly 100 AD and 1750 AD as a "wood and water" complex. In other words, wood and water were the primary materials used in many forms for Western technology in this period. While I think that this description is generally correct, what I would like you to do is to attack this generalization. That is, write an essay in which you argue that Mumford's "wood and water" generalization does not hold. Use specific examples of machines or processes that support your argument. Of course, be sure also to point out instances in which the generalization is correct.

(Essay Question Grading Guidelines)

1. Students have to tell why generalization is correct:
   wood -used for energy, fire for heat, smelting metals, etc.
   -used for lots of construction, houses, building
   water -used for power, water wheels
   -used for navigation, transport

2. In attacking the generalizations, students should point out:
   Wood not only material used for construction
   Metal used in lots of things
   for plows (coulter [knife] and plowshare)
   for weapons-firearms, armor in shock combat
   for stirrups
   Metal used in instruments such as clocks, compasses
   used in steam engines
   used in printing press
   used in horseshoes
   Stone and masonry-also used in place of wood
   Glass-used in building

   Wood and water not only energy resources
   Wood use complemented by use of coal, especially in England
   Animal energy still used in agriculture, where most of population made living
   Man power used in mining and other activities
   Wind power complements water power
   Steam power at end of Middle Ages

HISTORY OF TECHNOLOGY
THE INDUSTRIAL REVOLUTION

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INTRODUCTION

During the period from 1700 to 1900, Western civilization became characterized by the emergence of many novel technologies, such as powerful engines, rapid communications and transportation systems, and towering architectural masterpieces. The period spans what is known as the Industrial Revolution, which began in Great Britain in the 1700s and which spread to the United States and elsewhere in the 1800s. In this course, we will examine the causes, manifestations, and consequences of the Industrial Revolution in the Western world. We will focus on some of the major technological innovations and see how they influenced the evolution of other technologies and the people who used them. In studying this history, we will not accept technology uncritically. Rather, we will examine it to learn how it has acted as a powerful force in changing society.

This course is the second of a three-quarter sequence in the history of technology. In the fall, we offered History 4211, which concerned the history of ancient and medieval technology from prehistoric times to 1700. History 4213, deals with the history of modern technology from 1900 through 1987. [The syllabi for these courses are also printed in this volume, Editor]

COURSE REQUIREMENTS

One mid-term examination, a paper, and a final examination. Grades will be assigned on the basis of the following approximate formula:

Mid-term exam:	30%
Paper:	25%
Final Exam:	30%
Class participation:	15%

For the paper, I will ask you to choose an invention or technological process and discuss how and why it was developed. What was its use, and what impact did it have on society? The paper should be 2-3 typed pages, with references listed. It is due the 14th class period. More instructions will be handed out later in the quarter. [For details on the paper see p. 46, Editor] Students having special needs or handicaps should contact the professor early in the term for assistance in overcoming problems.

REQUIRED READINGS

Booklet of duplicated short articles for purchase as a complete set. These required readings are listed after the title of each lecture, below.

COURSE SCHEDULE
[This quarter-length course meets bi-weekly, Editor]

1. Course Introduction

THE INDUSTRIAL REVOLUTION

2. The Agricultural Background to the Industrial Revolution in England
   E. R. Chamberlin, "Changes in English Agriculture," in Allan Mitchell and Istvan Deak, eds., **Everyman in Europe: Essays in Social History**, 2nd ed., v. 2, (Englewood Cliffs, N.J.: Prentice Hall, 1981), pp. 7-9.
   Paul Bairoch, "Agriculture and the Industrial Revolution, 1700-1914," in Carlo Cipolla, ed., **The Industrial Revolution** (London: Collins/Fontana, 1973), pp. 452-466.
   Peter Mathias, **The First Industrial Nation** (New York: Scribners, 1969), pp. 59-82 ("Landownership and Change in Rural Society").

3. Steam Engine Development
   Eugene S. Ferguson, "The Origins of the Steam Engine," **Scientific American** 210 (Jan. 1964): 72-81.

4. Open

5. Steam Engine Development, continued
   "Letter from Matthew Boulton to Erasmus Darwin, 4 January 1790," in Jennifer Tann, ed., **The Selected Papers of Boulton and Watt**, v. 1 (Cambridge, Mass.: MIT Press, 1981), pp. 72-74.

6. The Textile Industry and Factory System
   D.S.L. Cardwell, **Turning Points in Western Technology** (New York: Science History, 1972), pp. 73-101 ("The Origins of Modern Technology" and "Arkwright and His Contemporaries").
   J. Bowditch and C. Ramsland, eds., **Voices of the Industrial Revolution** (Ann Arbor: University of Michigan Press, 1968), pp. 82-90 ("Child Labor in Factories and Mines").

7. Coal and Iron in the Industrial Revolution
   John R. Harris, "The Rise of Coal Technology," **Scientific America** 231 (Aug. 1974): 92-97.
   Christine Vialls, **Coalbrookdale and the Iron Revolution** (Cambridge: Cambridge University Press, 1980), pp. 9-14 ("Cast Iron").
   W. David Lewis, **Iron and Steel in America** (Greenville, Del.: Hagley Museum, 1976), pp. 25-34 ("Iron and Steel in the New Nation").

8. Revolution in Transportation: Canals and Steamboats
   Francis T. Evans, "Roads, Railways, and Canals," **Technology and Culture** 22 (Jan. 1981): 1-34.
   John S. McNown, "Canals in America," **Scientific American** 235 (July 1976): 116-123.
   Daniel J. Boorstin, **The Americans: The National Experience** (New York: Vintage Books, 1965), pp. 97-107 ("Getting There First") and pp. 107-112 ("The Democracy of Haste").

9. Revolution in Transportation: Steam Locomotive
   Alfred D. Chandler, Jr., **The Visible Hand: The Managerial Revolution in American Business** (Cambridge, Mass.: Belknap Press, 1977), pp. 81-121 ("The Railroads: The First Modern Business Enterprises").

10. Film: **Drive for Power** in J. Bronowski's "Ascent of Man" Series
    Concluding remarks
    William L. Langer, "The Social Question," in A. Mitchell and J. Deak, **Everyman in Europe**, v. 2 (Englewood Cliffs, N.J.: Prentice Hall, 1981), pp. 40-46.

11. MID-TERM EXAMINATION

THE REVOLUTION SPREADS

12. Setting for Technology in America
    Nathan Rosenberg, **Perspectives on Technology** (Cambridge: Cambridge University Press, 1976), pp. 9-31. ("Technological Change in the Machine Tool Industry").
    "Conclusions" in **The American System of Manufactures** (Parliamentary report on American manufacturing by George Wallis and Joseph Whitworth, 1855), reprinted with an introduction by Nathan Rosenberg (Edinburgh: Edinburgh University Press, 1969), pp. 387-389.
    David A. Hounshell, **From the American System of Mass Production, 1800-1932** (Baltimore: Johns Hopkins University Press, 1984), pp. 15-65. ("The American System of Manufactures in the Antebellum Period").

13. Iron Structures and Engineering
    Carl W. Condit, "Buildings and Construction," in Melvin Kranzberg and Carroll W. Pursell, Jr., **Technology in Western Civilization**, v. 1 (New York: Oxford University Press, 1967), pp. 367-392.
    David P. Billington, "Bridges and the New Art of Structural Engineering," **American Scientist** 72 (Jan.-Feb. 1984): 22-26.

14. The Origins of Modern Engineering; PAPER DUE
    Edwin Layton, "Mirror-Image Twins: The Communities of Science and Technology in 19th Century America," **Technology and Culture** 12 (Oct. 1971): 562-580.

15. The Mechanization of Agriculture
    Harold C. Livesay, **American made: Men Who Shaped the American Economy** (Boston: Little, Brown, and Co., 1979), pp. 53-89 ("The Grim Reaper: Cyrus Hall McCormick").

16. Science-Based Technology: The Chemical Industry
    Aaron J. Ihde, **The Development of Modern Chemistry** (New York: Harper and Row, 1964), pp. 443-471 ("The Chemical Industry, I: The Nineteenth Century").

17. Electricity and Technology: Background
    Thomas P. Hughes, "Thomas Alva Edison and the Rise of Electricity," in Carroll W. Pursell, Jr., ed., **Technology in America** (Cambridge, Mass.: MIT Press, 1981), pp. 117-128.

18. Science-Based Technology: Electric Power and Communications
Thomas P. Hughes, "The Electrification of America: The System Builders," **Technology and Culture** 20 (Jan. 1979): 124-139.

19. Business and Technology: A link to the 20th century
Leonard S. Reich, **The Making of American Industrial Research: Science and Business at GE and Bell, 1876-1926** (New York: Cambridge University Press, 1985), pp. 1-11, 37-41 ("The Importance of Industrial Research").

20. Conclusion

21. and 22. FINAL EXAMINATIONS

QUESTIONS TO GUIDE READINGS

Because some of the readings assigned are rather complex, you may find the questions below helpful. You should be able to answer each of these questions on the basis of the readings, and may be tested on the questions on the examinations.

Chamberlin, "Changes in Agriculture."
1. What was the enclosure movement?
2. What advantages and disadvantages did it have?
3. How did the movement support the Industrial Revolution?

Bairoch, "Agriculture and the Industrial Revolution."
1. How much of the population in pre-industrial Europe worked in agriculture? How much surplus did farmers produce? What was the "risk-of-famine limit?"
2. What evidence is there of a break in agricultural techniques and productivity in the 18th century?
3. What six agricultural techniques and methods are cited that contributed to higher productivity?

Mathias, "Land Ownership."
1. What were the three main groups of people affected by changes in agriculture in 18th-century England?
2. What agricultural innovations were introduced in 18th-century England? Who did they benefit?
3. What new crops were grown in England, and what advantages did they confer upon people and animals?

Statistics.
1. When did cotton production in the US gain a large share of the world market? What countries consumed the most cotton?
2. How much of US exports in the early 19th century were of cotton (and other agricultural products)? How much did the US export in manufactured goods? What do these figures say about the nature of the US economy?

Harris, "Coal Technology."
1. Why did coal become a major fuel in England before the Industrial Revolution?
2. According to the article, what were the revolutionary advances in British technology that occurred during the first decade of the 18th century?
3. Why didn't coal technology transfer easily to the Continent?

Ferguson, "Steam Engine."
1. What were some of the impacts of the Newcomen engine?
2. Describe the major features of the Newcomen & Watt engines. What similarities and differences existed between them?
3. What does Ferguson mean by the "genius of James Watt"?

Letter from Boulton to Darwin about Watt's engine.
1. What advantages does the Watt engine have over the Newcomen engine and water wheels?

Cardwell, "The Origins of Modern Technology."
1. What are the four basic processes in making textiles?
2. What had England's wealth traditionally depended on?
3. When and how did the mechanization of weaving occur?
4. Why was it important that spinning and weaving be efficiently mechanized in the late-18th century?
5. What was unusual in John Smeaton's approach to water wheels?

Cardwell, "Arkwright and his Contemporaries."
1. Why did Samuel Crompton call his invention a mule?
2. What further inventions became necessary after the invention of the water frame, spinning jenny and mule?
3. What does cotton spinning have to do with the way in which people work?

Child Labor in Factories and Mines.
1. When did the British Parliament become concerned about labor conditions in industry?
2. What kinds of factories and mines are mentioned in the testimony?

Vialls, "Cast Iron."
1. When did iron-making begin? How was it originally done?
2. Why did people smelt with charcoal?
3. What problems were there in smelting with coke? How were they overcome? Who was responsible for the initial success in using coke? Why?

Lewis, "Iron and Steel in America."
1. What were the chief uses of iron in Colonial America?
2. What is a blast furnace used for? How does it work?
3. What is charcoal? pit iron? wrought iron? steel?

McNown, "Canals."
1. How much weight can a horse carry as a packhorse? drawing a wagon? pulling a barge?
2. Describe the first US canals. What were they used for? Why was the Erie canal built?
3. What impact did the success of the Erie canal have?
4. How did canals and railroad growth compare in the 1800s?

Evans, "Roads, Railways, and Canals."
1. What technical improvements were made in roads, canals, and railroads in England between 1760 and 1840?
2. What impact did these improvements have for sustaining the Industrial Revolution?
3. What was the synergistic relationship between railroads and canals in the early days of locomotives? How did the relationship change?

4. Did one type of transportation system totally exclude all others after 1825?

Boorstin, **The Americans.**
1. What kind of engine was used on steamboats on the western rivers? Why?
2. What risks did people run in order to achieve the benefits of steamboats?
3. What effects did cultural attitudes towards "getting there first" have on the construction of railroads in America?
4. Why was the American opportunity to travel a great "equalizer"? Did US trains have different classes of service?

Chandler, "The Railroads."
1. How did the technologies of railroads and telegraphs interact?
2. How long did it take to travel from New York to Chicago in 1800? 1830? and 1857? What made for the differences?
3. What organizational innovations helped railroads win a victory over waterway technologies? What role did new financial and accounting techniques play?

Langer, "The Social Question."
1. What was the underlying cause of the "pauperization" of much of the European population in the decades preceding 1848?
2. Who managed to live in relative comfort during this period?
3. Why did employers so often hire women and children?

Rosenberg, "Conclusions."
1. List six features of the United States that Whitworth found very different from England.

Hounshell, "American System."
1. What is a definition for the "American system of manufacturing"?
2. What was the British workshop system, and how did it differ from the American factory system?
3. How commercially successful was Eli Whitney as the inventor of interchangeable parts?
4. What features distinguished the American system on the eve of the Civil War?

Condit, "Buildings and Construction."
1. When was iron first used for construction? What effects did this innovation have?
2. What innovations did Americans add to traditional techniques for building with wood?
3. What are the main uses for concrete? Why?

Billington, "Art of Structural Engineering."
1. What was the new art form that the author describes?
2. Who exemplified the art form and in what structures?

Layton, "Mirror-Image Twins."
1. What is the traditional picture of the relation between science and technology?
2. Why does Layton think this model is inadequate? Give two reasons.
3. What is the significance for this debate on the rise of the engineering profession?

Livesay, "Grim Reaper."
1. How many laborers did it take to harvest two acres of what per day in 1820?

2. What three "keys" were needed to unlock the potential wealth of the American Midwest?
3. What problems did the McCormick reaper solve?
4. How did McCormick market the reaper?

Ihde, "Chemical Industry."
1. Describe the Leblanc process and its rise as the predominant method of making soda? What was soda (and other alkalis) used for?
2. For what reasons was the rise of the coal tar chemical industry significant? Why did the Germans dominate the industry?

Hughes, "Thomas A. Edison."
1. Why was Edison's "invention factory" a novel idea?
2. Why did Edison attack the electric light project in 1878? What did the project lead to?
3. What institution did Edison spawn in the US through his successes?

Hughes, "Electrification."
1. What does the author mean by "system building"?
2. What was Edison's contribution as a system builder?

Reich, "Industrial Research."
1. What were the different functions of early industrial research laboratories?
2. How does the author characterize industrial research?
3. What benefits did companies gain from industrial research?

MID-TERM EXAMINATION INFORMATION

You will be asked to write an essay on one of the following three essay questions. At the time of the test, I will tell you which one to write on. To prepare for it, you may want to make outlines of your arguments and fill them in with details and examples from your readings and class notes. However, you may NOT use the outline during the exam. It is a closed book test. The essay will be worth about 30-50% of the test grade. There will also be a short answer section and/or a multiple choice section on the exam.

Possible Essay Questions

I. The Industrial Revolution can be characterized by change. In an early lecture, I outlined some changes in:

*building materials	* sources of motive power	* transportation
*energy sources	* forms of production	* agricultural techniques

Now that we have discussed some of these changes in detail, I want you to choose and describe three of these changes and discuss how they contributed to the success of the Industrial Revolution. Also explain what impact these changes had on the way people worked and lived.

II. A historian of technology recently wrote:

> "The steam engine is the ultimate symbol of the Industrial Revolution. In every advance that characterizes the revolution, one finds the steam engine

playing an integral role in helping to bring that advance to fruition. In the fields of mining technology, the textile industry, iron production and machining, and transportation sectors, the steam engine found its niche and had wide ranging implications, both positive and negative."

In this essay, I want you to support the above statement with detailed arguments and specific examples. Be sure to identify the specific steam engine and describe briefly what feature of it made the advances possible.

III. England was the first country to undergo an industrial revolution. Give three possible reasons why this was so, and discuss the plausibility of each reason. Also explain which industries dominated the revolution during different periods. Why did these industries succeed each other as they did?

FOR ALL THESE ESSAYS, BE SURE TO PROVIDE SPECIFIC EXAMPLES. YOU WILL BE PENALIZED FOR UNSUBSTANTIATED CLAIMS.

MID-TERM EXAMINATION

PART I. MULTIPLE CHOICE: (30 points) In the following multiple choice questions, there are one or two correct answers. Circle the correct answer(s) and write it (them) on your answer sheet. [The correct answers are circled, Editor]

1. England was the first country to undergo an industrial revolution partly because of A) the surplus of wood resources for smelting iron; B) a tradition of luxury industries; C) a parasitic aristocracy; D) high duties on goods passing provincial duties; (E) a national banking system.

2. The dramatic change in agricultural productivity before and during the Industrial Revolution in the period between 1600 and 1800 is associated with A) the three-field system; B) the use of steam engines on farms; C) the McCormick reaper; (D) the enclosure movement; E) John Kay's spinning wheel.

3. The use of coal for many industrial processes in England A) led John Smeaton to develop a method for improving the efficiency of Savery steam engines; B) was the direct cause of the "social question"; (C) resulted partly from deforestation; D) resulted in increased charcoal production; (E) resulted in increased coke production.

4. James Watt's contributions to steam engine technology and theory included A) the geometric concept of triangular motion so that the piston could transmit power up and down; B) the invention of a technique for boring smooth cylinders for steam engines; (C) the use of double-acting steam in the engine; (D) the invention of the condenser; E) the invention of the prodenser.

5. Among the important figures in the mechanization of spinning was (were) A) John Kay; B) John Smeaton; (C) Richard Arkwright; D) Henry Jenny; (E) John Wyatt.

6. Which of the following helped American railroad trains run fast? A) safe, straight tracks; (B) the bogie; C) the twilight zone system; (D) the telegraph system; E) low pressure engines.

7. Charcoal-fired blast furnaces often had which of the following ingredients put into them? A) coal; B) pig iron; C) carbon dioxide blown in by bellows; (D) iron ore; (E) limestone.

8. Why did employers in industrial England so often hire women and children? A) they enjoyed working more than men; B) Parliament passed laws forbidding hiring discrimination based on sex or age; (C) they worked for lower wages than men; (D) they could do the work as well as men (in most factories) and were more tractable; E) they received tax credits for hiring these "hard-core" unemployed.

9. Among those who contributed to the success of the Watt steam engine was (were): A) John Kay; (B) John Wilkinson; C) Sears Roebuck; (D) Matthew Boulton; E) John Smeaton.

10. In the 1820s and 1840s, the British Parliament heard testimony and passed laws concerning A) employment conditions in steam engine factories; B) social security benefits for mine workers; (C) working hours for women and children in textile factories; D) construction of fireproof factories; E) the support of the Confederacy in the coming American Civil War due to the South's abundance of raw cotton for use in English textile mills.

PART II. FILL-INS: (30 points) In the following sentences, missing words are represented by blanks. On the answer sheet, write your precise and concise answers that correspond to these blanks. They can be answered in a few words. [Correct answers are placed in the blanks, Editor]

11. The most efficient transport system in England at the beginning of the 19th century was the (canal) system, which was supplemented by a feeder system of (railroads or lakes and rivers).

12. What was the major innovation in the production of cast iron made in the early 18th century? (use of coke) Who made it? (Darby) [Note: If the question is altered to read "wrought iron" instead of "cast iron" and "late 18th century" instead of early 18th century" the answers would be puddling and Cort.]

13. What modification had to be made to the steam engine before it could be used in textile mills? (given ability to produce rotary motion)

14. Name the major advantage of high pressure steam engines that enabled them to be used on mobile platforms. (smaller or lighter)

15. Name two new crops grown in England in the period before the Industrial Revolution. (clover, lucernes, sainfoin [leguminous crops] and turnips, mangels) What advantages did each one offer? (fixed nitrogen in the soil and extra feed for animals)

PART III. ESSAY: (40 points) Be sure to provide specific examples and a complete analysis, not just a recitation of unconnected facts.

A historian of technology recently wrote:

> "The steam engine is the ultimate symbol of the Industrial Revolution. In every advance that characterizes the revolution, one finds the steam engine playing an integral role in helping to bring that advance to fruition. In the

fields of mining technology, the textile industry, iron production and machining, and transportation sectors, the steam engine found its niche and had wide ranging implications, both positive and negative."

In this essay, I want you to support the above statement with detailed arguments and specific examples. Be sure to identify the specific steam engine and describe briefly what feature of it made the advances possible.

(Essay Question Grading Guidelines)

I am not so interested in the details of different engines except where the discussion relates to impacts. Just descriptions of engines will not do.

In the essay, I want to see people's mastery of how steam engines were used. I imagine most people will omit discussion of the negative impacts. If so, deduct points.

*Mining technology: Savery engine was first, but not successful. Unsafe. Newcomen engine combined safety and durability and reliability. Very important to aid draining of water in coal mines, especially. Permitted more coal to be mined. Coal was the fuel of industrial England, so Newcomen engine was important invention. (i.e., positive impact)

*Textile Industry: Watt engine used here to replace water wheels. Engine with rotary motion feature made the transition possible. Now, factories could be located away from water and in towns where more people lived. Factory system with machines setting the pace was the rule. Positive impact: lots of capital generated for industrialists, some of which went into other industries, lots of cheap products. Negative impact: unfeeling and impersonal factory system, exploitation of workers.

*Iron production and machining: Watt engine used where water wheels were used previously, i.e., for powering bellows in blast furnaces; i.e., for turning cylinders in Wilkinson's boring mills and etc.

*Transportation Sector: Watt low pressure steam engine was used for first successful steamboat (by Fulton). But it was superseded by lighter weight high pressure engines for steamboats and locomotives. Impact: In England and US removed bottleneck in transportation (aside from canals); in US helped make country into economic and political unit. Negative: In US, steam transportation was pushed to limits for speed. Real carnage on waters and RR tracks.

FINAL EXAMINATION INFORMATION

You will be asked to write an essay on one of the following three essay questions. At the time of the test, I will tell you which one to write on. To prepare for it, you may want to make outlines of your arguments and fill them in with details and examples from your readings and class notes. However, you may NOT use the outline during the exam. It is a closed book test. The essay will be worth about 30-50% of the test grade. There will also be a short answer section and a multiple choice section on the exam.

Possible Essay Questions

I. An historian recently wrote:

> "A major feature of 19th-century technology was the ubiquitous mechanization of the American economy. Machines used in the production and distribution of goods made it possible for the nation to take advantage of its vast (and apparently infinite) material resources that led ultimately to the emergence of the country as a world power."

In this essay, I want you to support this statement. To do this properly, be sure to analyze the reasons for American mechanization and describe two examples in which mechanization eliminated serious problems that had previously inhibited economic growth. Also be sure to explain what impact mechanization had on both the people who used the new machines and on those who did not.

II. A historian of technology recently wrote:

> "The 'engineer' of 1899 was of a different breed than his counterpart a century earlier. In his schooling, social organization, workplace, and desire to specialize, he looks more like the modern, 20th-century engineer than anyone else. In a sense, the 19th-century revolution in technology was accompanied by a revolution of the engineer."

In this essay, support the historian's assertion by describing how and why engineering became transformed in the 19th century. Explain the reasons for the changes listed by the author and offer specific examples to bolster your argument. Then give two counterexamples of engineers who did NOT necessarily fit into the mold of modern engineers. In what ways did these atypical 19th-century engineers differ from the "modern" engineer described in the quotation? Why were they successful in spite of their "deficiencies?"

III. Railroad technology has the strange habit of showing up frequently in various discussions concerning the industrialization and growth of the United States in the 19th century. In this essay, you should explain the great number of ways the railroad was at once a product of the Industrial Revolution as well as a technology that contributed to the momentum of that revolution. Be sure to write about how the railroad made an impact on associated technologies and how it created the need for innovations in fields outside of "pure" engineering and technology.

FOR ALL THESE ESSAYS, BE SURE TO PROVIDE SPECIFIC EXAMPLES FROM CLASS NOTES AND READINGS. YOU WILL BE PENALIZED FOR UNSUBSTANTIATED CLAIMS.

FINAL EXAMINATION

PART I. FILL-INS: (30 points) In the following sentences, missing words are represented by blanks. On the answer sheet, write your precise and concise answers that correspond to these blanks. They can be answered in a few words at most. [Correct answers are placed in blanks, Editor]

1. Iron was perhaps the most revolutionary new building material used in the 19th century. Besides iron and wood, what other building material had been around for centuries and found new uses in the 19th century? (concrete) What was a major use of this material? (lighthouses, bridges, foundations)

2. What business "innovation" resulted from companies like Duke's cigarette company and others that produced tremendous amounts of goods using mechanized and quickly operating equipment? (horizontal integration, trusts, cartel) What two technological innovations served as the infrastructure for business in the middle of the 19th century? (railroad) (telegraph)

3. What two 19th-century industries did not grow out of traditional craft knowledge? (electrical industry) (chemical industry) Name one industry that did emerge from traditional craft knowledge. (iron forging, glass, etc.)

4. Name two associated inventions made by Edison that accompanied his electric light bulb in his power system. (improved dynamo, light fixtures, parallel wiring system, electric meter) Name one of the two companies that successfully competed against Edison in the electricity supply business. (Thomson-Houston or Westinghouse)

5. Name two commercially successful telegraphy systems (defined by the names of the inventors) that resulted from scientific discoveries of electromagnetism. (Morse, Cooke-Wheatstone)

6. Name two industries that arose as a result of the manufacturing of coal gas (also known as manufactured gas or "town" gas). (synthetic dyes, synthetic pharmaceuticals)

PART II. MULTIPLE CHOICE: (30 points) In the following multiple choice questions, there may be one or two correct answers. Circle the correct answer(s) and write it (them) on your answer sheet. [Correct answers are circled, Editor]

7. Cyrus McCormick's invention and marketing of the mechanical harvester was successful because: A) McCormick's company was the first big business to become vertically integrated; B) the machine enabled six laborers to harvest two acres of wheat a day; (C) because the company sold the machines on credit and with warranties, similar to many modern, 20th century businesses; D) the machine served as all three keys to unlock the potential wealth of the American Midwest; E) the original reaper used a Watt steam engine to provide reliable power.

8. According to the article by Hounshell, the American system of manufacturing can be characterized by which of the following statements: (A) It employed machine tools that shape metal through the use of cutting implements; B) It developed in response to the need of bicycles and automobiles; C) Interchangeability of parts was exact and universal for all finished products after Whitney showed how to make this possible; (D) Arms producers were among the first to exploit the technique in the 1800s; E) The British found it was impossible to transfer to countries having different political systems.

9. Industrial research laboratories in late 19th and early 20th century America: A) had not yet achieved the same successes as the Germans in the electric lighting industry; B) were created to produce rapid, short term advances through the purchase of outside patents; (C) often were begun cautiously by managers who at first did not realize the potential benefits of industrial research; (D) were stimulated by successes at companies such as Standard Oil; E) developed first among companies that produced steel, because of the necessary scientific knowledge needed to use use the material.

10. Which statement(s) concerning the coal tar industries is (are) true? A) The Germans started the industries but they had moved to England by 1900; B) Karl Duisberg established the standard arrangement of industrial research laboratories in England in which glass blowers, analysts, chemists, etc. were housed in a building separate from the manufacturing business; (C) the Dyestuffs industry developed the first industrial research laboratories because of the need to meet whimsical and constantly changing demands for new dyes; D) The coal tar industries took a clue from Edison's laboratories to set up their own; E) Germany entered the coal tar industries as World War I was looming and the need for chemicals was pressing.

11. Steel in the 19th century: A) was used in designing buildings so that they would look just like older buildings (in terms of size and style) but made with different materials; B) was replaced by wrought iron in railroad tracks; (C) was manufactured in a "converter" beginning in the late 1850s; D) was produced in greater quantities in Great Britain by 1895 than in any other country, helping keep that nation at the lead of the Industrial Revolution; E) was manufactured in the US by small companies throughout the 19th century.

12. According to Layton, the author of the article "Mirror Image Twins," the mirror image dichotomy of scientists and engineers: (A) has contributed to the divergent views of social responsibilities held by the two professions; B) suggests that engineers in universities hold a great amount of prestige; (C) means that engineers and scientists have reversed value systems; D) leads to the view that science in the 20th century usually develops as a result of technological needs; E) explains why engineers began receiving college educations.

13. According to British observers, a successful atmosphere for manufacturing goods in America was made possible by: A) the limited natural resources that necessitated the use of machines; B) the large number of British immigrants; C) the large number of laboring classes; (D) widespread education of the masses; E) years of political struggle against a tyrannical colonial power.

14. The American setting for technology in the 18th and early 19th centuries (before 1830) included: A) an agrarian work ethic that always looked favorably upon the use of technology and manufacturing industries; (B) a belief that technology as used in manufacturing would aid in keeping the country free from England; C) several engineering schools on the par of the French écoles that were founded in America before the American revolution; D) abundance of consulting scientists working in universities; (E) lots of physical resources that had been exhausted in other countries.

PART III. ESSAY: (40 points) Be sure to provide specific examples and a complete analysis, not just a recitation of disconnected facts.

An historian of technology recently wrote:

> "The 'engineer' of 1899 was of a different breed than his counterpart a century earlier. In his schooling, social organization, workplace, and desire to specialize, he looks more like the modern, 20th-century engineer than anyone else. In a sense, the 19th-century revolution in technology was accompanied by a revolution of the engineer."

In this essay, support the historian's assertion by describing how and why engineering became transformed in the 19th century. Explain the reasons for the changes listed by the author and offer specific examples to bolster your argument. Then give two counterexamples of engineers who did not necessarily fit into the mold of modern engineers. In what ways did these atypical 19th-century engineers differ from the "modern" engineer described in the quotation? Why were they successful in spite of these "deficiencies?"

(Essay Question Grading Guidelines)

I. Introduction: Student should explain that Industrial Revolution of the 19th century could be characterized by dramatic changes in building materials (esp. iron), transportation (RR, steamship), and communications (telegraph). A revolution in the engineer occurred simultaneously and as a result of these changes.

II. How and why engineer changes? With examples.

A. Schooling - because of use of new materials, especially. iron, chemical products, electricity, engineer needed specialized scientific education to learn how to use materials. They went to new schools to get this education. Examples: West Point Military Academy, Rensselaer Polytech, VPI, etc.

B. Social Organization - As engineers earned new identity, they became more "professional" and established societies that established minimum standards, assured quality, performed PR. Examples: Am. Soc. of Mech. Engineers, AIME, etc.

C. Workplace - More and more engineers worked in industrial research labs, not their basements and workshops -- reflects how technology became more science-based. Examples: GE labs, Bell Telephone labs, Dupont, etc.

D. Need to specialize: As new fields emerged, a need to understand their technical foundations was necessary. Thus, one needs to master fundamentals of electricity to be an elect. engineer. No time to do other things. Ex: electrical engineer, chemical engineer.

III. Two Counterexamples

1. T. Edison - little schooling, little specialization, but he hired people who had schooling in lots of different fields to make up for deficiencies.

2. C. McCormick - invented mechanical harvester - was not formally educated, but worked in ancient field of agriculture - was able to bring fruits of modern technology (iron) to an ancient endeavor.

HISTORY OF TECHNOLOGY
TECHNOLOGY IN THE 20th CENTURY

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COURSE DESCRIPTION

Technological change has occurred rapidly in the 20th century, contributing to the remaking of our physical and social environments. In this course, we will examine the causes and manifestations of technological evolution and discuss how humankind, especially in America, has benefited from it and accommodated to it. By studying case histories, we will see how technology has changed in substance and in organization through the century. In addition, the course will focus on how the government and public have become increasingly involved in motivating and limiting technological innovations.

Generally, the course seeks to develop an understanding of the forces and circumstances that affect the way technology evolves and the way technology affects the ways humans live and work. The course is divided in two sections, "Technology's Effects on Society" and "Society's Effects on Technology," to reflect the course's emphasis on the reciprocal impacts of technology and society.

This course is the third of a three-quarter sequence in the history of technology. In the fall, we offered History of Technology 4211, which concerned the history of ancient and medieval technology from prehistoric times to 1700. History of Technology 4212, offered during the winter term covered the period from 1700 to 1900. Enrollment in earlier courses is <u>not</u> a prerequisite for registration in HIST 4213. [The syllabi for the earlier courses are also printed in this volume, Editor]

COURSE REQUIREMENTS

One mid-term examination, one paper, and a final examination. Grades will be assigned by the following approximate formula:

Mid-term exam:	30%
Paper:	25%
Final exam:	30%
Class participation:	15%

For the paper, you will choose an invention or technological process and discuss how and why it was developed. What was its use, and what impact did it have on society? The paper should be 2-3 typed pages, with references listed. It is due the 14th class period. More instructions will be handed out in a few days. [For details on the paper see page 46, Editor] Rules for class participation will also be distributed. Students having special needs or handicaps should contact the professor early in the term for assistance in overcoming problems.

REQUIRED READINGS

Unfortunately, there are no good textbooks for the history of recent technology. Therefore, I have compiled about 40 articles that you can purchase as a complete set. These required readings are listed after the title of each lecture.

COURSE SCHEDULE

[This quarter-length course meets bi-weekly, Editor]

TECHNOLOGY'S EFFECTS ON SOCIETY

1. Course Introduction
   Peter F. Drucker, "Out of the Depression Cycle," **Wall Street Journal** (Jan. 9, 1986): 26.

2. Background--American Technology in the 19th century
   Carroll W. Pursell, Jr., and Melvin Kranzberg, "The Promise of Technology for the Twentieth Century," in Melvin Kranzberg and Carroll W. Pursell, Jr., eds., **Technology in Western Civilization**, v. 2 (New York: Oxford University press, 1967), pp. 3-10.
   Hugo A. Meier, "Technology and Democracy, 1800-1860," in John G. Burke and Marshall C. Eakin, ed., **Technology and Change** (San Francisco: Boyd and Fraser, 1979), pp. 211-213.

3. Technology and Industrial Management
   Daniel J. Boorstin, **The Americans: The Democratic Experience** (New York: Random House, 1973), pp. 361-370 ("Time Becomes Fungible: Packaging the Unit of Work").
   W. F. Ogburn, "National Policy and Technology," excerpts from **Technological Trends and National Policy** (1937), in Charles R. Walker, ed., **Modern Technology and Civilization: An Introduction to Human Problems in the Machine Age** (New York: McGraw Hill, 1962), pp. 43-52.
   Frederick W. Taylor, excerpt from **Principles of Scientific Management** (1911), in Carroll W. Pursell, Jr., **Readings in Technology and American Life** (New York: Oxford University Press, 1969), pp. 240-248.

4. Revolution in Transportation: Automobiles
   Lynwood Bryant, "The Origin of the Automobile," **Scientific American** 216 (March 1967): 102-112.
   James J. Flink, "Henry Ford and the Triumph of the Automobile," in Carroll W. Pursell, Jr., ed., **Technology in America** (Cambrdige, Mass.: MIT Press, 1981), pp. 163-175.

5. Revolution in Transportation: Airplanes
   F.E.C. Culick, "The Origins of the First Powered, Man-carrying Airplane," **Scientific American** 241 (July 1979): 86-100.

6. Technology and Women
   Ruth Schwartz Cowan, "From Virginia Dare to Virginia Slims: Women and Technology in American Life," **Technology and Culture** 20 (Jan. 1979): 51-63.
   Rosalind Williams, "The Other Industrial Revolution: Lessons for Business from the Home," **Technology Review** 87 (July 1984): 30-40.

7. Technology and the Future: People's Views of Technology as a Panacea
   "If This Is the Future. .," **Science 84** 5 (Jan.-Feb. 1984): 34-43.
   David Sarnoff, "The Fabulous Future," in **Fortune Magazine**, ed., **The Fabulous Future: America in 1980** (New York: E. P. Dutton, 1955), pp. 13-31.
   John Von Neumann, "Can We Survive Technology?" in **Ibid.**, pp. 32-47.

8. Invention in Modern America
   Jacob Schmookler, "Economic Sources of Inventive Activity" (1962), in John G. Burke and Marshall C. Eakin, **Technology and Change** (San Francisco: Boyd and Fraser, 1979), pp. 396-399.
   John Jewkes, David Sawers, and Richard Stillerman, "The Sources of Invention" (1969), in **Ibid.**, pp. 406-416.

9. The Electronics and Computer Revolution
   Ray Hammond, "Understanding the Computer--Pt. 1" in **Computers and People** (May-June 1984): 15-25, and "Understanding the Computer--Pt. 2," in **Ibid.** (July-Aug. 1984): 17-20.
   "Little Brain Cells," **Time** (July 12, 1948): 54. [Original account of the transistor's invention]
   "The Tiny Transistor," **Newsweek** (Sept. 6, 1948): 44.

10. Open

11. MID-TERM EXAMINATION

SOCIETY'S EFFECTS ON TECHNOLOGY

12. Government and Technology: Background
   James P. Baxter, III, excerpt from **Scientists Against Time** (1943), in Carroll W. Pursell, Jr., **Readings in Technology and American Life** (New York: Oxford University Press, 1969), pp. 384-393.
   Henry DeWolf Smyth, excerpt from **Atomic Energy for Military Purposes** (1945), in **Ibid.**, pp. 394-399.
   Vannevar Bush, excerpt from **Science--The Endless Frontier** (1945), in **Ibid.**, pp. 408-422.

13. Government and Technology: The Space Race as a Case Study
   Home E. Newell, **Beyond the Atmosphere: Early Years of Space Science** (Washington, D.C.: NASA, 1980), pp. 87-99 ("Response to Sputnik: The Creation of NASA").
   Richard Hutton, **The Cosmic Chase** (New York: Mentor, 1981), pp. 69-111 ("Man Arrives, Politics Follow").
   Arlen J. Large, "Once a Huge Fizzle, Men to Mars Idea is Enjoying a Revival," **Wall Street Journal** (Jan. 23, 1985): 1.

14. The Restive Public of Science and Technology
   PAPER DUE TODAY
   Dorothy Nelkin, "Science and Technology Policy and the Democratic Process," in Albert Teich, ed., **Technology and Man's Future**, 3rd ed., (New York: St. Martin's Press, 1981), pp. 270-293.
   Alvin M. Weinberg, "Science and Trans-Science," **Minerva** 10 (April 1972): 209-222.

15. Energy Use and Energy Technologies in America

"Ten Years After the Oil Embargo: What Have We Learned?, **Nucleus** [published by Union of Concerned Scientists] 5 (Fall 1983): 3-4.

Daniel Bell, "Plenty and Profligacy: Energy and Growth in America," in Melvin Kranzberg and Timothy A. Hall, eds., **Energy and the Way We Live** (San Francisco: Boyd and Fraser, 1980), pp. 13-15.

Norman Metzger, "Prelude to Crisis," in **Ibid.**, pp. 16-18.

"Reagan Energy Plan Reluctantly Unveiled," **Science** 213 (July 31, 1981): 520-521.

Roger G. Noll, "Assessing the Energy Situation," **Science** 208 (May 16, 1980): 701-702.

Youssef M. Ibrahim, "A New Era in Energy May be Commencing as OPEC Flounders," **Wall Street Journal** (Dec. 16, 1985): 1.

16. The Electric Power Industry as an Infrastructure for Business and Society

Thomas P. Hughes, **Networks of Power: Electrification in Western Society, 1880-1930** (Baltimore: Johns Hopkins University press, 1983), pp. 201-226 ("Chicago: The Dominance of Technology").

17. The Electric Power Industry in Transition: 1960s-Today

Richard F. Hirsh, "How Success Short Circuits the Future," **Harvard Business Review** 86 (Mar.-April 1986): 72-76.

18. Nuclear Power and Public Policy

William J. Lanouette, "Nuclear Power--An Uncertain Future," in Melvin Kranzberg and Timothy A. Hall, eds., **Energy and the Way We Life** (San Francisco: Boyd and Fraser, 1980), pp. 331-343.

Myron Kayton, "Nuclear Power--Yes," in **Ibid.**, pp. 344-346.

Sam Love, "It Was Too Good to be True," in Lee Stephenson and George R. Zachar, eds., **Accidents Will Happen: The Case Against Nuclear Power** (New York: Harper and Row, 1979), pp. 6-16.

Petr Beckmann, **The Health Hazards of NOT Going Nuclear** (Boulder, Colo.: Golem Press, 1976), pp. 11-34 ("The Nuclear Monologue").

"Overview," in John G. Kemeny, **et al., The President's Commission on The Accident at Three Mile Island** (Washington, D.C.: Government Printing Office, 1979), pp. 7-25.

19. The Decline of American Technology and Industry?

William Stockton, "The Technology Race," **New York Times Magazine** (June 26, 1981): 17-18, 49-56.

Alfred L. Malabre, "Gap between US, Foreign Wages Widens," **Wall Street Journal** (July 17, 1985): 6.

Brian Rungeling, "The State of US Productivity," **Orlando Sentinel** (Aug. 5, 1985): Central Florida Business Section, 10.

Sylvia Nasar, "Good News Ahead for Productivity," **Fortune** (Dec. 10, 1984): 40-50.

Michael A. Cusumano, **The Japanese Automobile Industry: Technology and Management at Nissan and Toyota** (Cambridge, Mass.: Harvard University Press, 1985), pp. 1-26 ("Introduction: A Half Century of Growth, Protection, and Promotion").

20. Course Conclusion

Langdon Winner, "The Political Philosophy of Alternative Technology," in Albert H. Teich, ed., **Technology and the Future**, 4th ed, (New York: St. Martin's Press, 1986), pp. 301-316.

Robert Engler, "Technology Out of Control," **The Nation** 240 (April 27, 1985): 488-500.

21. and 22. FINAL EXAMINATION

QUESTIONS TO GUIDE READINGS

Drucker, "Depression Cycle."
1. What does Drucker mean by the shift from an energy economy to an information economy?
2. How has technology aided this shift?
3. What is the difference between the mechanical and biological model? How does technology fit into both models?

Pursell and Kranzberg, "Promise of Technology."
1. Give examples of the acceleration of technology in the 19th century.
2. Why are the 1900s known as the "American century"?
3. Was everyone optimistic about the future of technology and society?

Meier, "Technology and Democracy."
1. What is meant by "surrender to the machine"?
2. What is the "materialistic approach" to technology?

Boorstin, excerpts from **The Americans**.
1. What does "efficiency" mean in the 20th-century American gospel?
2. What are the basic features of Taylor's scientific management?
3. What were the result of Mayo's experiments?

Ogburn, "National Policy and Technology."
1. During what period in American economic and political history did Ogburn write this report?
2. What major technological advances that affected society does Ogburn describe as occurring in the previous 35 years? What were their effects?
3. How do scientific achievements produce social changes in the eyes of the author? Explain his billiard ball analogy.

Taylor, "Scientific Management."
1. How did Taylor eliminate "soldiering" in the factory?

Bryant, "Origin of Automobile."
1. What are the basic advantages of the internal combustion engine?
2. What other engines did the very early internal combustion engines resemble?
3. Why did Otto employ a four-stroke engine?

Flink, "Henry Ford."
1. Why did the Model T have "more important consequences than Lenin's socialist revolution"?
2. Why did the automobile culture develop so rapidly in the US?
3. Describe Ford's innovations.

Culick, "Airplane."
1. What did Cayley, Penaud, Lilienthal, & Chanute contribute to aeronautics?
2. What is "wing-warping"?
3. Why were the Wright brothers successful in building an airplane?

Cowan, "Women and Technology."
1. What basic differences between men and women have effects on the technologies they use?
2. What are the "economic facts of life" for women?
3. How have household tasks changed for women?
4. How are women "antitechnocrats"?

Williams, "Other Industrial Revolution."
1. What is meant by the industrial revolution of the home?
2. How did the "age of homespun" end? What is the significance of the end of this age?
3. What were the unforeseen end results of industrialization?
   Why are women not necessarily grateful to modern technology?
4. What is the importance of men sharing in housework?

Science 84.
1. Give examples of technological predictions that came true?
   Give examples of those that did not come true?
2. What explains the failures of many predictions?

Sarnoff, "Fabulous Future."
1. What were the author's qualifications to write on the technical future of America?
2. Why did Sarnoff claim that "whatever the mind of man visualizes, the genius of modern science can turn into functioning fact"? Was he correct?
3. What were Sarnoff's predictions concerning nuclear power? What other predictions about technology and society did he make? How accurate were the predictions?

von Neumann, "Can We Survive."
1. What is the crisis described by the author?
2. Compare von Neumann's attitude about the future with Sarnoff's.

Schmookler, "Inventive Activity."
1. What motivates invention, according to Schmookler?
2. What are some psychological factors for invention?
3. What is an almost inevitable accompaniment of progress?

Jewkes, "Sources of Invention."
1. What are some assumptions concerning the nature of technological innovation?
2. What does the example of nylon's history tell us?
3. Where has the emphasis on public endeavor been in recent times? What are the possible results of such a policy?

Hammond, "Understanding the Computer."
1. What are the origins of the modern computer?
2. How did World War II stimulate computer research?
3. What does the author see for the future of computers? What problems may exist?

Original Accounts of Transistor.
1. What hopes did people raise for the transistor?

Baxter, excerpt from **Scientists Against Time**.

1. Why did the British government see the military need for science and technology before the American government?
2. Why couldn't the National Academy of Sciences organize science and technology before World War II?
3. How did the NDRC support research?
4. What were the accomplishments of NDRC research contracts?

Smyth, "Atomic Energy."

1. How much did the Manhattan project cost up to June 1945?
2. Who were involved in the building and testing of the bomb?
3. What was the justification for using the weapon?

Bush, "Endless Frontier."

1. What is Bush's basic thesis concerning science, technology, and the government?
2. How did he develop this thesis?
3. What benefits did he see accruing from research in science?
4. What did Bush mean by "scientific capital"?
5. What was Bush's program for action?
6. What did Bush say about "basic" research? industrial research?
7. What were Bush's fundamental requirements for a national science policy?

Newell, "Response to Sputnik."

1. Why did the US become so competitive with the Soviet Union in space activities?
2. What were the two major interest groups vying for control of the US space program?
3. Why did space science flourish within the new NASA?
4. What kind of space program did the US have before NASA?

Hutton, "Man Arrives, Politics Follow."

1. What were the ramifications of events occurring on April 12, 1961?
2. What was the significance of the Voskhod flights?
3. What problem did NASA encounter in the mid-1960s?
4. What occurred in the space program about the time Americans walked on the moon?
5. Why did NASA struggle to survive after the lunar landing?
6. What were some arguments against the Apollo program and space exploration in general?
7. What tangible and intangible benefits did the space program provide?

Mars clipping.

1. What were the American plans for travel to Mars?
2. Why were the plans being discussed again in 1985?

Nelkin, "Science and Technology Policy."

1. Why is the relationship between science and the public being renegotiated?
2. What are the public's attitudes toward science and technology?
3. What are the implications of a "technical elite"?
4. What are the mechanisms and channels of public participation in science and technology decision making? What problems and implications are involved?

Weinberg, "Science and Trans-Science."

1. What does "trans-science" mean?
2. Why is engineering a trans-science?
3. What is the "republic of trans-science"? How does it differ from the "republic of science"?

4. What are the advantages and disadvantages of conducting the trans-scientific debate in public?

"Ten Years After."
1. What changes in public attitude and public policy occurred between 1973 and 1983?
2. Why is the author optimistic about the future of energy policy?

Bell and Metzger, "Energy" readings.
1. What has been the traditional attitude toward use of energy resources in America?
2. What were some of the early warnings of energy crisis?
3. How did political and social changes affect energy use in the 20th century?

"Reagan Energy Plan" and "Assessing the Energy Situation."
1. What is Reagan's energy policy?
2. What type of energy research will benefit? deteriorate?
3. What are the different approaches toward a coherent energy policy?

"A New Era in Energy."
1. How have energy planners changed their attitudes since 1985?
2. How are oil companies and economists rethinking strategies?

Hughes, "Chicago."
1. What was the background of Samuel Insull?
2. Why did Insull call for state regulation of electric power? What did regulation have to do with his technological strategy?
3. Why did Commonwealth Edison succeed in selling electricity cheaper than most other utilities?

Hirsh, "Success Short Circuits."
1. In what ways was the electric utility industry successful in the first 70 years of the 20th century.
2. What changed in the 1970s?

Lanouette, "Nuclear Power."
1. What caused the uncertain future for nuclear power?
2. What are the unresolved safety problems and other concerns surrounding nuclear power?
3. How does the public view nuclear power?

Kayton, "Nuclear Power."
1. Why is Kayton still optimistic about nuclear power?

Love, "Too Good to Be True."
1. What hopes did people have for nuclear power?
2. How did the government help the nuclear power industry?

Beckmann, "Nuclear Monologue."
1. What is meant by a "nuclear monologue"?
2. How did the nuclear industry become so defensive?
3. What are the arguments for the superiority of nuclear fuel over fossil fuel?
4. What is the opinion of scientists and engineers on the nuclear power issue?

Kemeny, "Overview."
1. What were the causes of the TMI accident?
2. How serious was the accident?
3. How effectively did the NRC handle the accident?
4. What was the basic problem with the TMI reactor? What kind of business attitude prevailed before the accident?

Stockton, "Technology Race."
1. Why is American technology faltering?
2. What will remedy the situation?
3. What is the consequence of reduced spending for science and technology?

"Gap between US Foreign Wages Widens."
1. What do wage differences and productivity have to do with each other?
2. In what industries and with what countries is the disparity of wages the greatest? What is the significance of these gaps?

"State of US Productivity."
1. What has been the trend of labor productivity in the US in the last ten years?
2. What can be said about higher productivity in Japan?

"Japan and the Economics of Invention."
1. What are the advantages and disadvantages to the US of Japan's "inventiveness" and technological leadership?
2. In what fields do the US and Japan invest most heavily for R&D? Do you think the proportions are appropriate?

"Good News."
1. What are the causes of higher US productivity in the 1980s?
2. What anxiety do US businesses have about progress in productivity?

Cusumano, "Japanese Auto Industry."
1. How did the Japanese auto industry emerge? How did the Japanese government help and hinder the industry?
2. In the 1980s--unlike the 1950s and 1960s--why have Japanese customers preferred domestic cars rather than foreign-made cars?

Winner, "Alternative Technology."
1. What are the standard tenets of technological orthodoxy? Are they valid?
2. Why are technologies never neutral?
3. How are "services" reinstitutionalizing the patterns of everyday life?

Engler, "Out of Control."
1. What examples does Engler give for technology out of control?
2. What does the author mean by "normal accidents"?
3. Why does Engler challenge the "assumption that marketplace is the sole arbiter of what technologies should be introduced and the assertion that their transfer abroad is a private affair?

MID-TERM EXAMINATION INFORMATION

You will be asked to write an essay on one of the following three essay questions. At the time of the test, I will tell you which one to write on. To prepare for it, you may want to make outlines of your arguments and fill them in with details and

examples from your readings and class notes. Make sure you have answered all the sub-questions too. You may NOT use the outline during the exam. It is a closed book test. The essay will be worth about 30-50% of the test grade. There will also be a short answer section and a multiple choice section on the exam.

Possible Essay Questions

I. Technological innovations have affected society and civilization through several avenues: 1) by changing economic productivity; 2) by making products available to large segments of the population; and 3) by altering geographic and social mobility. Not all of the impacts of new technologies are necessarily positive. Social costs often must be paid in order to enjoy the benefits of new technologies.

In this essay, demonstrate how technological innovation has altered 20th-century society. In particular, I want you to offer one example each of a 20th-century innovation that has affected society through each of the four avenues (4 examples total) listed above. Discuss the history of the innovation so as to indicate how and why it was developed and how it influenced society through the particular means (i.e., its impact). Make sure you also describe those parts of society that benefited from the innovation and those that were disadvantaged by it. Finally, assess whether the individuals (or groups of people) who made the innovations foresaw the extent to which their new technologies would have an impact on society.

II. Big companies seem to have played a major role in the history of technology during the late 19th and 20th centuries. This role constituted a major change over the early and mid-19th century. In this essay, A) describe first how large corporations emerged in the American economy at the end of the 19th century; B) then provide three examples of important innovations in technological products or processes that were made by big corporations; C) why were these innovations so important? D) next, describe why big companies were able to displace individuals and dominate the scene; E) finally, discuss the impact--positive and negative, potential and realized--that these huge organizations have on society.

III. While big companies seem to dominate the technological landscape of 20th century America, individuals have been significant contributors to innovation as well. Often these people demonstrated inventive talent in making single, yet seminal, innovations. Others synthesized elements of existing technologies and ultimately became entrepreneurs who controlled the big corporations. In this essay, discuss in detail three individuals who made technological innovations in the 20th century. What was so important about their contributions? How did other people or companies use the innovations? Did they encounter problems in patenting their devices? Why? What impacts on the economy and society did these individuals have?

MID-TERM EXAMINATION

PART I. MULTIPLE CHOICE: (33 points) In the following questions, there are one or two correct answers. Read the questions carefully. Circle the correct answer(s) on this question sheet and write it (them) on your answer sheet. [Correct answers are circled, Editor]

1. The materialist approach to technology: A) provided for high quality products for the small upper class market; B) was of little concern to engineers, inventors, mechanics, and their spokesmen; (C) consists of the use of technology to provide comfort, speed, and abundance for the American public; D) consists of the use of natural resources that are at hand for technological advancement in developing nations; E) required the existence of a large, well-trained, engineering elite.

2. The views of the future as portrayed in your readings included which of the following: A) Sarnoff and von Neumann both had unqualified enthusiasm for technology and society in the next 25 years; (B) Sarnoff thought that one result of the creation of more material abundance through the application of new science and technology would be man's spiritual growth; C) Von neumann believed that the crisis of technology's relationship to geography and political organization would be alleviated by 1980; D) It was generally believed that aside from atomic weapons, knowledge of nuclear science would have few practical applications; E) Only one or two of the predictions of fanciful new technologies noted in the readings ever came to fruition.

3. The multi-piston (two or four piston) arrangement of the internal combustion engine had the function of: A) reducing the number of moving parts in the engine; B) allowing internal combustion engines to use gasoline; (C) helping to drive out exhaust gases; D) helping to provide a stratified charge; E) lowering fuel consumption.

4. Ford's Model-T automobile became a relatively inexpensive car in the 1920s because: A) demand was low, supply was high; B) Ford used batch production techniques, whereby workers moved from one stationary car to another; (C) there was only one model of car that Ford sold; D) Ford workers were underpaid; E) Ford sold the car at a loss to gain a competitive edge.

5. Among the techniques used by the Wright brothers in designing their successful airplane of 1903 was (were): (A) changing the shape of the wings in flight; B) use of water tunnels for testing wing shapes and drag forces; C) use of a lightweight steam engine for power; (D) adopting the type of wing structure devised by Octave Chanute; E) use of a retractable landing gear to reduce drag.

6. Some aspects of 19th-century technology and American society that transferred to the 20th century included: A) a popular belief that technological progress should be encouraged by the government; B) an extensive highway network that enabled companies to develop national markets; (C) large companies that employed scientific methods to develop new commercial products; D) skepticism over technological advance; E) dependence on British factories for cheap products.

7. Contributions to aeronautics made by Cayley, Penaud, Lilienthal, and Chanute include: A) wing warping; B) simulation of a bird flight for airplanes; (C) development of airfoils; D) concept of lighter-than-air flight with balloons; E) analysis of the different forces acting on airplanes.

8. Associated with the concept of mechanization of tasks in 19th-century America was (were): A) skilled labor surplus; (B) skilled labor shortage; C) "tooling up" machines; D) the "British System of Manufactures"; E) use of assembly lines to produce cars.

9. The "industrial revolution in the home": A) describes armies of women and children toiling in mills; B) referred to the return of manufacturing to the home; i.e., the recreation of "cottage industries"; (C) refers to the use of new appliances in the home that eased the burden of chores; (D) implied to one school of thought that, despite new technology entering the home, women's time in doing work in the home remained the same over the last 60 years; E) elimination of sex-typed jobs.

10. Schmookler contends in his article on sources of innovation that inventive activity may result from which of the following: A) satisfaction with existing conditions; (B) latent demand; (C) antecedent scientific discoveries; D) expectation of economic penalties; E) regressive patent laws.

11. The term "rationalization" of industry often refers to: A) the use of mathematics to determine fair wages for managers of companies; (B) a "scientific" approach toward the management of skilled labor; C) government support of industry; (D) assembly line, mass-production techniques; E) college-educated managers.

PART II. FILL-INS: (27 points) In the following sentences, missing words are represented by blanks. On the answer sheet, write your precise and concise answers that correspond to these blanks. They can be answered in a few words. [Correct answers are placed in the blanks, Editor]

12. The use of electricity in factories at the beginning of the 20th century offered several advantages that led to greater productivity and efficiencies. Name three of them. (less fire hazard) (more efficient factory setup) (more productivity through better energy efficiency) etc.

13. The symbol of Taylor's scientific management was the (stopwatch; shovel given partial credit).

14. Predictions of the future are often viewed as "conservative" because they reflect (hopes) and (fears) more than views of the future based on "scientific" methods of technology assessments.

15. Give an example of what Cowan means by women being "antitechnocrats." (women opposed to nuclear technology; women taught to be users of technology and not makers, etc.)

16. Give two reasons why the bicycle was an important technological predecessor to the automobile. (lots of technology transferred [frames, gearing mechanisms, pneumatic tires, etc.]) (spurred on a road movement) (gave people more desire to have personalized transportation technologies)

PART III. ESSAY: (40 points) Be sure to provide specific examples and a complete analysis, not just a recitation of unconnected facts.

Big companies seem to have played a major role in the history of technology during the late 19th and 20th centuries. This role constituted a major change over the early and mid-19th century. In this essay: A) describe first how large corporations emerged in the American economy at the end of the 19th century; B) then provide three examples of important innovations in technological products or

processes that were made by big corporation; C) why were these innovations so important? D) next, describe why big companies were able to displace individuals and dominate the scene; E) finally, discuss the impact--positive and negative, potential and realized--that these huge organizations have on society.

(Essay Question Grading Guidelines: Good Essay Written by a Student)

The large corporation emerged in the mid-19th century due to a variety of factors present in America at that time. Many of these corporations could be said to be based on the big, new technologies of the times: electricity, communication, transportation, and between these technologies and the corporations a symbiotic relationship developed. These new technologies supported large corporations, and in turn the large corporation supported new technologies. Another idea which lead to the emergence of the large corporation was the concept of vertical organization - in which a single company controlled the whole process of the production of a product: from supply to manufacturing to distribution and marketing. The most important factor, however, in the early life of the large corporation was the existence of the large railroad network at the end of the 19th century. This allowed communication across the whole of the US which was not before present. It allowed the development of a national market. A corporation then needn't serve only its local region, but could take advantage of the fact that they could exploit the whole nation as a market.

In the growth of the large corporations several new technologies (symbiotic relationship) were developed. One of the more subtle innovations to come out of these large corporations was a direct result of the exploitation of the rail network: the development of the idea of marketing by the Swift corporation. They had to sell the idea that it would be good to eat meat killed 3-4 days before in the Midwest in New England. This was the first major example of a need to convince a market that they wanted (needed) a corporation's goods. In the modern corporation, marketing and its child--advertising--take up a major portion of a corporation's resources.

Another major innovation of the big corporations was the development of the industrial research labs. GE and other such corporations developed within them divisions which had no other major function than the development of new technologies for the corporations. This is the most concrete example of the relationship between technology and the large corporation. These research labs were important in that they were the source of many of the new technologies of the 20th century. They were so important that the technologies of the Bell Research Labs contributed greatly to its parent, the monster AT & T.

The most obvious innovation made by a big corporation, and the symbol of 20th century manufacturing, occurred in the Ford Motor Company. Here the corporation took the already present concepts of mass production, specialization of work, and the continuity of the assembly line and integrated them into a single manufacturing process. This changed the total nature of the way things were made. The Ford Corporation's mass production/assembly line techniques allowed products to be made cheaply and fast. It also confirmed the presence of the big corporation in America: only a big corporation could afford the machinery for this system, and the small company couldn't compete with the massive numbers and low cost of products produced that way.

The large corporation definitely made an impact in America of the early 20th century. It dominated industry through several means. The high cost of the assembly line/mass production techniques and the competition brought on by the use of them drove many small companies out of existence. The existence of the national market and exploitation of this by the national based corporations drove out many of the local or regional companies. The new technologies made many old industries obsolete (gas, carriage [horse], wood stoves) and supported the big corporations. The ability of these larger corporations to hold monopolies - both the illegal monopolies (in spite, despite anti-trust laws) and the legal monopolies created by the manipulation of patents (with the development of a new self-censuring specialty, the patent lawyer) tended to frustrate new companies or individual inventors to the point where they either: one, gave up; two, sold to the large corporations; or three, joined the large corporations. While it is true then that these large corporations gave the US much of its technological growth, improvement of the standard of living, new technological ideas and inventions, it did so at the cost of rigidity (as shown by Western Union refusing to listen to Bell; they thought they had the whole communication industry sewn up), control of new technology (AT&T, IBM requiring one to sell one's soul when they join the company - any developments theirs), and stagnation (AT & T, IBM setting up new technologies in order to maintain market for old technologies).

FINAL EXAMINATION INFORMATION

You will be asked to write an essay on one of the following three essay questions. At the time of the test, I will tell you which one to write on. To prepare for it, you may want to make outlines of your arguments and fill them in with details and examples from your readings and class notes. Make sure you have answered all the sub-questions too. You may NOT use the outline during the exam. It is a closed book test. The essay will be worth about 30-50% of the test grade. There will also be a short answer section and a multiple choice section on the exam.

Possible Essay Questions

I. Governmental agencies and institutions have played important roles in American technological development during the 20th century. In this essay explain the effects of the government as it has played each of the following roles:

1) Advocate of technological innovation
2) Regulator of technological inovation
3) Legislative arbiter of technological innovation (i.e., providing the legislative authority to proceed with or limit a technology).

For each role, provide at least one example of the government's involvement in technology. Make sure you explain why the government was involved in the technology in the first place. Also describe what might have occurred without government involvement. (Would the technological innovations have been produced or limited in the absence of governmental institutions?) Finally, provide a brief rationale for either the abolition or continued existence of the government's role-playing in the development of technology.

II. The 20th century has witnessed the emergence of "big" technology--technology that is highly complex, dependent upon numerous synergistic systems, and very

costly. Examples of this technology include A) space technology; B) electric power systems; C) nuclear power technology; and D) computers. Chose three of these four examples and answer all these questions:

1) Why are these considered "big" technologies?
2) What factors influenced their development?
3) How has the public responded to them?
4) What future developments occurring in the United States do you see for these technologies? Why?

III. An historian recently wrote:

> "In the 20th century, technology has become public. No longer does the engineer make the decisions about his work alone and in a social vacuum. He or she now works in a context of politics and public concern. The engineer's assumptions and choices are often questioned, and well intentioned technological 'fixes' to problems are often discarded in the public arena."

In this essay, use information derived from the second part of the course, readings, and experience to attack or support this statement. In doing so, use the concept of "trans-science" (make sure you define it, too) and provide THREE examples of "public" technologies. Why have these technologies become subject to public debate? What are the problems and implications of a trend toward public involvement in technological decision making.

FINAL EXAMINATION

PART I. SHORT ANSWERS: (20 points) On the answer sheet, write your precise and concise answers that correspond to the blanks. [Correct answers are placed in the blanks, Editor]

1. What kind of "frontier" did Vannevar Bush envision for science after World War II? (endless) In 1945, what kind of national science policy did the United States have already in place for the post-war period? (none) What kind of policy did the government have by the mid-1950s and later? (decentralized, pluralistic, piecemeal, etc.)

2. An event similar in impact to the Sputnik launch in 1957 occurred in 1961. What was it? (launch of Russian astronaut into space; Yuri Gagarin) What American program did it lead to? (Apollo program; manned moon program)

3. The electric utility industry promoted energy sales heavily in the 1950s and 1960s. Give one reason why increased energy sales, which stimulated the need for costly new generating equipment, were promoted. (Don't just say "to make money"--be more specific.) (economies of scale, led to decreased unit costs of electricity) Today, fuel costs that are higher than they were 15 years ago are among the reasons why the industry has stopped promoting indiscriminate use of electricity. What are two other reasons? (limits to technological progress, regulatory problems in building plants, high interest costs, inflation drove construction costs up)

4. Give the name (not just an acronym) and the activities of a US government agency that has served as an advocate of technological innovation.

(Department of Energy, NASA, Energy Research and Development Administration, not NRC) (Give away question!) Aside from the Nuclear Regulatory Commission, what government agency has had the job of regulating the safety of nuclear power? (Atomic Energy Commission)

PART II. MULTIPLE CHOICE: (45 points) In the following questions, there is only one correct answer. (Thank goodness!) Read the question carefully. Circle the correct answer on this question sheet and write it on your answer sheet.

5. According to some observers of recent events in technology and business (such as Engler in his article, "Technology Out of Control"): A) businesses have been regulated in such a way that technological systems in other countries are safer than in the US; B) accidents such as those that occurred in Bhopal are exceptional events that will not occur often; (C) the marketplace has been allowed to be the sole arbiter of what technologies should be introduced in foreign countries; D) the public in the US is too often consulted in determining the feasibility of new technological systems; E) "normal accidents" should not be expected to occur frequently in the US due to government regulation.

6. The Reagan administration's energy policy: A) embraces a highly regulated market philosophy toward energy use; B) seeks heavy regulation of energy producers, but not of consumers; C) reiterates the Carter administration's desire to establish a domestic synfuels industry with active government involvement; (D) differs sharply from that of the Carter administration's on conservation and renewable energy; E) seeks to produce much of the nation's energy needs (up to 20%) with renewable energy sources within 20 years.

7. Among the reasons for the uncertain future of nuclear power in the US is: A) government regulatory policies concerning coal plants; B) that nuclear generated electricity, while cheaper than coal generated power, brings a small dose of radiation into the homes of users; (C) the long lead times for building nuclear power plants; D) that a large segment of the population refuses to use electricity; E) regulatory policies concerning the widespread use of electricity.

8. American technology is said to be slipping recently because: A) American universities are turning out too many M.S. and Ph.D. engineers; B) the US is not investing as much money on applied research as it does on basic research; C) the anti-technology movement has caused industries to spend more money on public relations efforts than for R&D; (D) industrial companies pursue short-term profits with the technology at hand rather than focus on long-term profits from new technologies; E) faculty members of university engineering departments are leaving to get better paying jobs in foreign countries where there is not a glut of engineers.

9. The President's Commission on the Accident at Three Mile Island concluded that: A) President Carter should not have visited the TMI plant so soon after the accident; (B) the Nuclear Regulatory Commission and the power industry may be responsible for the elimination of nuclear power as a viable source of energy; C) the way the accident was handled increased the public's confidence in the Nuclear Regulatory Commission; D) the people who suffered psychological distress from the accident must be considered "sacrifices to technological progress"; E) the technological system at TMI worked as planned during the emergency.

10. According to some experts cited by Stockton in "The Technology Race" and other articles, what would help to halt the decline in American technology? A) tax disincentives for investors in R&D companies; B) restrictions of Japanese imports; C) fewer graduate students in technology oriented programs; (D) another Sputnik-type event; E) less pay for electrical engineering graduates.

11. Among the contributions of Charles Babbage was: A) the concept for a steam turbine; B) using punched cards for performing census returns; C) founding one of the companies that eventually became IBM; D) the creation of the term "atomic bomb" in his book, War of the Worlds; (E) use of punched cards in a design of a computer.

12. Which statement about the history of computers is true? A) The transistor was a necessary invention for the development of the first electronic computers; B) In the 1950s, companies such as IBM built personal computers for sale to Japan, only to have their patents stolen by foreign imitators; (C) Digital computers were made possible in the 20th century (and not earlier) only because the hardware had advanced sufficiently by then; D) Electronic computing was aided by Shannon's work on base 10 logical circuits; E) Computer languages such as FORTRAN were replaced by easier programming with binary machine languages.

13. Even though new techniques have permitted the fuller exploitation of energy resources, Americans still faced a critical resource shortage in the 1970s because: A) government policies restricted exploration by American companies in foreign countries; B) continuous (i.e., automated) mining machines were outlawed in the 1960s as a result of growing environmental concerns over coal mining; C) of the end of tax incentives to encourage alternative sources of energy just as the first oil embargo of 1973 took place; (D) government policies that restricted exploration of energy resources in the US; E) coal replaced oil as the predominant fuel in the US.

14. Among the reasons why electric utility companies sought regulation in the early 1900s was: A) to assure high profits through the use of politically corrupt public service commissions; (B) to help assure them that they could take advantage of large-scale technology; C) to offset moves to nationalize power companies (i.e., to put them under government ownership); D) to encourage moves to nationalize power companies; E) to provide a justification for the creation of holding companies.

15. US government support of science and technology: A) was extensive from constitutional days until World War I; B) returned to pre-war levels after World War II; C) led to the successful launch of Sputnik in 1957; (D) led to a tremendous increase in funding for technical education in the late 1950s; E) none of the above.

16. Modern computers: A) can trace part of their heritage to traditions of automated candy vending machines; (B) owe something of their heritage to a weaving machine (Jacquard loom) of the early 19th century; C) had a predecessor in the machine invented by Boole in the 1850s; D) such as the Electronic Numerical Integrator and Computer (ENIAC) were invented in a garage by a pair of mechanical hobbyists; E) none of the above.

17. Among the mechanisms for public involvement in science and technology today are: A) court suits; B) business suits; C) pressure for the creation of new legislation; (D) A and C; E) none of the above.

18. What is the correct chronological order of introduction and widespread use of the following energy sources in the US since the late 19th century: A) coal, natural gas, oil, nuclear; B) oil, coal, natural gas, nuclear; C) natural gas, coal, oil, nuclear; (D) coal, oil, natural gas, nuclear; E) none of the above.

19. Which statement about government levels of support for technological R&D in different countries is true? A) The US government cannot spend money on R&D because the Constitution forbids it; (B) The Japanese government spends much less (on a percentage basis) on military R&D than does the US; C) R&D spending levels (as a percent of GNP) in the US have been decreasing the last few years; D) All of the above; E) None of the above.

20. **BONUS. No credit, but a good laugh at the end of the test: One calorie is the equivalent of: A) 4.184 joules; B) 4.185 joules; (C) 4.186 joules; D) 0 joules but 1 diamond; E) none of the above.

PART III. ESSAY: (45 points) Be sure to provide specific examples in an organized and well written essay.

An historian recently wrote:

> "In the 20th century, technology has become public. No longer does the engineer make the decisions about his work alone and in a social vacuum. He or she now works in a context of politics and public concern. The engineer's assumptions and choices are often questioned, and well intentioned technological 'fixes' to problems are often discarded in the public arena."

In this essay, use information derived from the second part of the course, readings, and experience to attack or support this statement. In doing so, use the concept of "trans-science (make sure you define it, too) and provide THREE examples of "public" technologies. Why have these technologies become subject to public debate? What are the problems and implications of a trend toward public involvement in technological decision making?

(Essay Question Grading Guidelines)

Definition of Trans-science = issues phrased in words of science but which cannot be answered simply in technical terms - usually requires public input

Why have these technological issues become subject to public debate.

1. Public funds lots of science & technology - public therefore deserves some say in where money goes
2. Public can be affected by technology individually--in this case risks are assumed by people and they can decide to take risk or not; put public is also affected by modern technology without choice of accepting risk - disaggregated risk
3. Public disenchantment with science and technology - Vietnam War, pollution

Three examples -
nuclear power, DNA, SST, high voltage electric power lines, saccharin, etc.

Problems
- people who get involved in decision making are not always knowledgeable i.e., problem with participatory mechanism.
- people's actions may delay or halt new technological innovations and make them more expensive

APPENDIX
Assignment Sheets Used in All Courses

I. Paper Assignment
II. Anchor-Person Assignment

I. PAPER ASSIGNMENT

A. Choose an invention or technological process and discuss it by answering the following questions:

1) Why and how was it invented? What need was there for the innovation? In other words, what was the background of this invention?

2) What did the invention do? Describe the innovation in enough detail so that I know you understand how it works. Why was it an improvement over what came before it?

3) What impact did the innovation have on society and on other technologies? How did it change people's lives, and how did it affect the development of other technologies.

The purpose of this paper is to give you more experience with concepts and themes in the history of technology. Your case study should provide insight into the nature of technological innovation and its impact on society.

Make sure the paper is historical and analytical--not just descriptive. In other words, I am not looking for a chronology of events. Rather, I want an in-depth historical analysis of the evolution of a technological device or process that explores the subject from both a social and technical perspective.

B. Guidelines:

1) The paper should be written on an innovation made during the time period we are studying in the course.

2) Do not write on an innovation I have lectured about (or will lecture about) in class. I want you to study something new. See me for approval before you begin work on the paper.

3) Make sure your paper is focused on one development only. You may write about the early plow, for example, but do not write about early agriculture. Or you can write about the Kodak camera, but do not write about all of photography. You may need to write about aspects of these broader subjects, but I want a narrowly focused paper on a single innovation.

4) There is no need to write gratuitous final paragraphs that praise the subject of your paper. Your subject does not need to have been the most significant invention in history to be worthy of a paper (i.e., don't overstate your case!).

5) List the sources of your information in a bibliography. Supply the Virginia Tech call numbers for the books you used. You should list at least five sources exclusive of encyclopedias. Make sure you check the periodical indexes as well as the card catalog.

6) The paper should be 2-3 typed pages long and double spaced. If it is longer than 3 pages, I will deduct 3 points for each extra page.

7) Include pictures, if they will help in describing the innovation. They will not be counted as pages, however, for the 2-3 page limit.

8) Proofread your paper to make sure you did not make spelling or typing errors. For every error more than 4, I will deduct 1/2 point. Feel free to use computer spell- and grammar-checkers.

9) On the page carrying the title of the paper and all subsequent pages, include only your student ID number--NOT YOUR NAME. This helps insure objectivity in grading.

10) Hand in the original and a xerox copy of the paper. (Keep another for yourself for safekeeping.) Just staple the pages together. There is no need for fancy report covers for the original or copy.

11) The word "it's" means "it is." Do not confuse the contraction with "its."

12) Enjoy and have fun. But don't wait until the last minute.

II. ANCHOR-PERSONS RESPONSIBILITIES

To encourage discussion and understanding in class, a few students will be designated "anchors" for each class. The anchor will be conversant in the subject of the day and will be called upon to discuss the reading or lecture content. The role of anchor will rotate throughout the class so that each student will participate at least once during the term. The class participation component of a student's grade will be based largely on his/her performance as an anchor.

Pre-Class Obligations:

1. Be totally conversant in the reading of the day.

2. Perform extra work in the library. Read about the subject in a good encyclopedia (such as the Britanica) and find other articles on the same subject (see the footnotes in the assigned articles, for example).

3. Hand in your list of outside sources, using any consistent style of bibliographic citation system (i.e., include the name of the article, its author, book/journal title, volume number, publisher, and page numbers). Don't list encyclopedia articles, though you may certainly use them to get citations for other readings.

In-Class Obligation: You may be asked to:

1. Summarize the major points of the readings.

2. Respond to questions from the professor.

3. Offer opinions based on the readings, previous classes and assignments, and experiences in life.

4. Respond to other students' questions and comments.

Rationale:

In the "real" world, you will often be expected to interact verbally with colleagues. You will need to think "on your feet" and be reasonably coherent. This activity will help in preparing for these situations. Also, even though class participation counts toward the final grade, many students are simply non-participants. This activity will force people to open up. As a side-effect, students will get a chance to know each other better than in most other classes.

Notes:

1. Don't get uptight about this exercise. It will take some time to get into the stride of participating comfortably. Moreover, don't be afraid to talk just because you may not be sure whether it's worthwhile or not. If you are uncertain about something, an open discussion will clarify matters.

2. Just because you are not an anchor-person does not relieve you of the responsibility of preparing for class. You never know when the instructor will get "mean" and ask other students about the assignment.

3. Make sure you have been an anchor at least once during the term. If you do not participate as an anchor, you will receive a "0" for a portion of your final grade.

4. Again, don't sweat it. Let's have fun with this.

TECHNOLOGY IN MODERN CIVILIZATION

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INTRODUCTION

Technology may well be the most conspicuous and powerful force shaping our civilization today. Some observers contend that technological development is a product of social change more than a cause. Both forms of interaction between technology and society have been basic to human development since primitive man began to raise himself above other animals by making and using tools. Especially in the past 200 years, the tool has become a machine which seems increasingly to dominate our civilization and our individual lives.

This powerful factor has received comparatively little attention in traditional history courses and other humanistic studies, at least until recently. Our course will examine the role of technology in the history of Europe and America from the Industrial Revolution to the present. This is a large topic and nothing like complete coverage can be achieved in a semester. Instead we will emphasize certain major developments as case studies in the interaction between technology and society. These will include: the steam engine and the factory, transportation and communications systems, technology in the home, the automobile, nuclear power, and the computer. Student interest and contributions will be a factor in determining the amount of attention given to individual topics and the possibility of bringing in additional topics not shown in the syllabus. There will be some tendency to give more attention to Britain and Europe in the early part of the semester and more to the U.S. in the later part. However, both side of the Atlantic will be kept in view throughout the course.

As a central theme, the course will consider the extent to which technology is controlled by, or controls, human beings. Has the quest for mastery of nature made us slaves of the machine? Do we still believe, as our 19th-century ancestors believed, that technological progress is giving us a better, freer, and happier life? Do we accept the present view that technology is "neutral" and that we can decide to use it for good or evil? Who or what decides how we live?

Less emphasis will be placed on the design of machines than on their impact upon society and the impact of society upon technological development. Some appreciation of the functioning of a device is helpful in understanding its social effects, and some students may wish to pursue this aspect in greater depth. However, extensive study of the "nuts and bolts" of various technologies will not be required. The course has no prerequisites, and no background in either technology or history is assumed.

CLASSES

A significant portion of class time will be used for informal discussion of the materials. This requires that the student have completed the reading and audio-visual assignments prior to discussion.

Class attendance and participation will be a part of your grade as shown below.

FIELD TRIPS

There will be two field trips as shown in the syllabus. However, these trips may be changed from the dates shown in order to best fit the convenience of students and to be acceptable at the places visited. Students will be asked to write a brief (1.5 - 2 page) report on each trip.

TESTS

The first test will be given in class and will consist mainly of essay questions with some identifications.

The second test will be a take-home essay test. The essay will be limited in length and will be due the class meeting after they are given out.

The final exam will be given in the classroom at the scheduled time. It will be comprehensive but will not include the reading prior to the first test.

GRADING

Grading will not be done "technologically," but your grade will not be lower than one based on the following percentages for course components.

2 Tests, average	38%
Project	25%
Class Participation	14%
Final Exam	23%

A make-up test or a late paper will receive a 5% deduction unless the student has a medical or other approved excuse.

PROJECTS

Each student should complete a project related to the course. The project may be a paper, an oral or audiovisual presentation, a model, a computer program, or some other form approved by the instructor. Students are encouraged to exercise imagination in choosing the topic and format, subject to the following guidelines and suggestions:

A. Projects must be based on significant research.

B. They must demonstrate the impact of a technology on society and/or the impact of social forces upon technology.

C. They must attempt to answer a definite question or questions or to support a thesis or argument.

D. Written projects should be about 10-15 pages long and have appropriate footnotes and bibliography. They should be typed or, better yet, word-processed.

E. Oral or audio-visual projects should require 15 minutes to 30 minutes to present and should be accompanied by a bibliography. The Learning Resources Center will help you to create an audio-visual project, but requires ample advance notice.

F. A Computer Science faculty member may be invited to participate in evaluating computer-based projects.

G. Model projects must be designed by the student to demonstrate the work or significant features of an artifact. They must be based on research, explained to the class, and accompanied by a bibliography. Consult with the instructor for further guidelines on this type of project.

H. Group projects are encouraged, but groups should normally be limited to two.

I. As shown in the syllabus, all students should submit project proposals by the 8th class period. In the following week, they should meet with the instructor to discuss these proposals, if they have not done so earlier. By the 17th class period students should submit a brief (1.5 - 2 page) summary of their work on the project to date, together with a preliminary bibliography. These preliminary reports should indicate the question(s) or problem(s) that will be addressed (not necessarily the answers). Preliminary reports will be graded on an excellent-satisfactory-unsatisfactory scale. Unsatisfactory reports should be re-done within a week after being returned to the student. All projects will be due by the 25th class period, but students with oral or audio-visual projects are urged to present them earlier, since we will not be able to crowd them all into the last few class periods.

J. All projects should be made available to the whole class.

K. Following are some suggestions for project topics:

1. A specific technological device and its relation to social change. Random examples might be: cotton spinning machines; steamboats on the Hudson River; the Atlantic Cable; the Edison phonograph; the Trans-Siberian Railroad; the Model-T Ford; the vacuum tube; birth control devices; the airplane in World War I; the space shuttle.

   [Note: General topics like "the railroad" or "the computer" are far too broad to handle but subdivisions of these topics might be excellent.]

2. A more obviously "social" topic such as: the Luddites; housing conditions in 19th-century Manchester; Women in the engineering profession; labor relations at G.M.; early TV programming; impact of urban freeways.

3. A "failed" technology, such as the steam car or the zeppelin. Explain why it did not achieve its apparent potential.

4. Oral history project: Interview someone who had close close personal contact with a socially important technology; for example, a present or former auto worker, steel worker, railroad worker, mine worker, or nuclear power worker; an engineer on an important construction project; someone who "invented" or participated in the development of a new device or product; or an elderly person who had close contact with a technology which has now disappeared. Do research on the topic before the interview and make your own written or oral presentation based on the interview and on your knowledge. Submit a bibliography.

5. A study of contemporary reaction to a technology in the past, based on newspaper and magazine articles from the first few years after it was introduced. Consider reasons for positive and negative reactions. How did the device affect existing life styles and attitudes? How did the anticipated consequences compare with the actual consequences?

6. The history of a specific artifact, such as a bridge, mill, railroad station, power plant, skyscraper, etc., emphasizing its interaction with society.

7. Examine the attitudes of a major intellectual or political figure toward specific technological changes of his or her day. Possible examples: Adam Smith, Karl Marx, Charles Dickens, Sigmund Freud, Napoleon III, Queen Victoria, Abraham Lincoln, Theodore Roosevelt, Winston Churchill, Adolf Hitler.

Consult the instructor for further suggestions and assistance on all types of projects.

TEXTS

Albert H. Teich, ed., **Technology and the Future**, 4th ed., (New York: St. Martin's Press, 1986).
David S. Landes, **The Unbound Prometheus** (Cambridge: Cambridge University Press, 1969).
Daniel Boorstin, **The Americans: The Democratic Experience** (New York: Random House, 1973).
Aldous Huxley, **Brave New World** (New York: Harper & Row, 1979).

On Reserve in Boatwright Library

Melvin Kranzberg and Carroll Pursell, eds., **Technology in Western Civilization**, 2 vols., (New York: Oxford University Press, 1967).
Additional articles listed under individual assignments are also on reserve.

Audio-Visual Materials

AV materials are considered as part of the assignments. Some will be shown in class; most will be viewed in the Learning Resource Center at times agreed upon by the students.

COURSE SCHEDULE AND ASSIGNMENTS
[This semester-length course meets bi-weekly, Editor]

1. Introduction
   Videotape: **The Trigger Effect** from the "Connections" series, Part I, Time/Life Films.

2. The Machine: Servant or Master? Discussion
   Teich, **Technology and the Future**, pp. 7-20 (Robert S. Morison, "Visions"); pp. 31-46 (Jacques Ellul, "The Technological Society"); pp. 72-93 (Emmanuel G. Mesthene, "The Role of Technology in Society").

3. Conditions of Technological Development
   Teich, **Technology and the Future**, pp. 47-58 (Robert M. Pirsig, "Zen and the Art of Motorcycle Maintenance").
   Bruce Mazlish, "The Fourth Discontinuity," **Technology and Culture** 8 (Jan. 1967): 1-15.
   Landes, **The Unbound Prometheus**, Introduction, pp. 1-12.

4. The Industrial Revolution in England: What, When, and Why?
   Landes, **The Unbound Prometheus**, pp. 43-95.

5. The Steam Engine
   Landes, **The Unbound Prometheus**, pp. 95-122.
   Eugene Ferguson, "The Origin of the Steam Engine," **Scientific American** 210 (Jan. 1964): 98-107.
   Videotape: **Thunder in the Skies**, from the "Connections" series.

6. Industrialization in Continental Europe
   Landes, **The Unbound Prometheus**, pp. 138-153, 174-197, 211-220.

7. The American System
   Landes, **The Unbound Prometheus**, pp. 307-310.
   Merritt Roe Smith, "Eli Whitney and the American System of Manufacturing," in Carroll W. Pursell, Jr., ed., **Technology in America** (Cambridge, Mass.: MIT Press, 1981), pp. 45-61.
   Boorstin, **The Americans: The Democratic Experience**, pp. 89-100.

8. First Field Trip: Early Richmond Industries -- Tredegar Iron Works and a Paper Mill.
   *Project Proposals Due.

9. The Transportation Revolution: Railroads and Steamships
   Kranzberg and Pursell, **Technology in Western Civilizations**, pp. 425-437.
   Landes, **The Unbound Prometheus**, pp. 201-204.
   Boorstin, **The Americans: The Democratic Experience**, pp. 332-336.
   Boorstin, **The Americans: The National Experience**, pp. 97-111.

10. Working and Living Conditions: Technology and Ideology
    Parliamentary Reports: "Child Labor in Factories and Mines" (from **Parliamentary Papers 1831-32**, v. 15, and **1842**, vols. 15-17), as reprinted in John Bowditch and Clement Ramsland, eds., **Voices of the Industrial Revolution** (Ann Arbor: University of Michigan Press, 1961), pp. 82-90.
    Thomas Carlyle, excerpts from **Past and Present** (1843) as reprinted in **ibid.**, pp. 91-107.

John L. and Barbara Hammond, excerpts from **The Rise of Modern Industry** (1925), as reprinted in Brian Tierney, Donald Kagan, and L. Pearce Williams, eds., **Great Issues in Western Civilization**, v. 2, 2nd ed., (New York: Random House, 1972), pp. 307-318.

Ronald M. Hartwell, "The Rising Standard of Living in England 1800-1850," **Economic History Review**, s. 2, 13 (1961): 397-416, reprinted as "Improvement Defended," in Philip A. M. Taylor, ed., **The Industrial Revolution in Britain: Triumph or Disaster?**, rev. ed., (Lexington, Mass.: D.C. Heath and Co., 1970), pp. 33-43.

11. First Test

12. The Communications Revolution: Telegraph, Telephone, Photography, etc.
Boorstin, **The Americans: The Democratic Experience**, pp. ix, 1-4, 305-306, 359-360, 370-386.

13. "Second" Industrial Revolution: Inventors and Engineers
Boorstin, **The Americans: The Democratic Experience**, pp. 523-546.
Landes, **Unbound Prometheus**, pp. 249-293.
Film: **Thomas Alva Edison**, 26 min., B&W, 1968, McGraw Hill Films

14. Home, Cities, and Environment: "High Victorian" Era
Boorstin, **The Americans: The Democratic Experience**, pp. 130-136, 245-246, 261-267, 307-308, 316-331, 346-358.

15. The Automobile
Boorstin, **The Americans: The Democratic Experience**, pp. 546-555, 267-273.
Landes, **Unbound Prometheus**, pp. 438-451.
J. Interrante, "The Road to Autopia" (pp. 89-104) and David L. Lewis, "Sex and the Automobile" (pp.123-133) from David L. Lewis and Laurence Goldstein, eds., **The Automobile and American Culture** (Ann Arbor: University of Michigan Press, 1983).
Film: **Henry Ford's America**, 57 min., color, 1977, CBS and National Film Board of Canada.

16. Mass Production; Assembly Lines
Boorstin, **The Americans: The Democratic Experience**, pp. 361-370, 165-166, 193-200.
Film: **Loose Bolts**, 30 min., color, Red Ball Films.

17. Mass Consumption: Interchangeable Human Beings?
Boorstin, **The Americans: The Democratic Experience**, pp. 109-136.
Film: **Modern Times**, 89 min., B&W, any video store.
Preliminary Project Summary and Bibliography Due.

18. The Mechanized Home, Family, and Community
Boorstin, **The Americans: The Democratic Experience**, pp. 434-447, 336-345, and 281-291.
Ruth Cowan, "The Industrial Revolution in the Home," **Technology and Culture** 17 (Jan. 1976): 1-23.

19. Second Field Trip: Smithsonian Institution
Second Test Due.

20. Energy and Environmental Crises; Oil and Superhighways
    Boorstin, **The Americans: The Democratic Experience**, pp. 41-52, 413-422.
    James Flink, **The Car Culture** (Cambridge, Mass.: MIT Press, 1975), ch. 7, pp. 191-233.

21. Limits to Growth
    Teich, **Technology and the Future**, pp. 154-176 (Donella H. Meadows, **et al.**, "Technology and the Limits to Growth"), pp. 178-192 ("The Global 2000 Report to the President"), and pp. 193-206 (Julian L. Simon and Herman Kahn, "The Resourceful Earth").

22. Technology in 20th Century War
    Landes, **Unbound Prometheus**, pp. 405-416 [Nazi Economy].
    Teich, **Technology and the Future**, pp. 95-121 (John McDermott, "Technology: The Opiate of the Intellectuals") and pp. 345-359 (William J. Perry and Cynthia A. Roberts, "Winning Through Sophistication").
    Film: **Memphis Belle**, 43 min., color, 1944, National Archives Trust Fund.

23. The Bomb and Nuclear Power
    Boorstin, **The Americans: The Democratic Experience**, pp. 579-590 (the bomb), 590-598 (space).
    Film: **Nuclear Power Pro and Con**, 50 min., color, 1979, McGraw Hill Films.

24. Electronic Communications
    Boorstin, **The Americans: The Democratic Experience**, pp. 470-477 (radio), 386-397 (television).
    Landes, **Unbound Prometheus**, pp. 423-430 (radio between the Wars).

25. The Computer
    Kranzberg and Pursell, **Technology in Western Civilization**, v. 2, pp. 309-323.
    Eli Ginzberg, "The Mechanization of Work," **Scientific American** 247 (Sept. 1982): special issue.
    Projects due.

26. The Information Society
    John Naisbitt, **Megatrends** (New York: Warner, 1983), ch. 1, pp. 1-33.
    Teich, **Technology and the Future**, pp. 59-71 (Alvin Toffler, "The Third Wave").
    Video-tape: **The Information Society**, 60 min., color, Aspen Institute for Humanistic Studies.

27. Is Technology Out of Control?
    Teich, **Technology and the Future**, pp. 214-218 (Peter F. Drucker, "New Technology: Predicting Its Impact"), pp. 245-257 (Allan C. Mazur, "Controlling Technology"), pp. 271-288 (Paul Goodman, "Can Technology Be Humane?"), pp. 301-315 (Langdon Winner, "The Political Philosophy of Alternative Technology").

28. Where Are We Headed?
    Teich, **Technology and the Future**, pp. 122-132 (Samuel C. Florman, "Technology and the Tragic View").
    Huxley, **Brave New World**.

SELECTED BIBLIOGRAPHY

This introductory list certainly does not include all important works on the history of technology. The topic headings used here are not exclusive; many of the books contain material related to more than one topic, but each book is listed only once.

This list includes only books, but much of the most important material is found in journal articles. The major American periodical in the field is **Technology and Culture**, the quarterly publication of the Society for the History of Technology. Other relevant journals include the **Journal of Popular Culture**, **Scientific American**, **History of Technology**, **Isis**, **Technological Forecasting and Social Change**, and **Technology Review** [from MIT].

A. GENERAL OR SURVEY HISTORIES OF TECHNOLOGY

Burlingame, Roger. **March of the Iron Men** (New York: C. Scribner's Sons, 1938).

Burlingame, Roger. **Engines of Democracy** (New York: C. Scribner's Sons, 1940).

Byrn, Edward W. **The Progress of Invention in the Nineteenth Century** (New York: Munn & Co., 1900).

Derry, Thomas K., and Trevor I. Williams. **A Short History of Technology from the Earliest Times to A.D. 1900** (London: Oxford University Press, 1960).

Hughes, Thomas P., ed. **The Development of Western Technology since 1500** (New York: MacMillan, 1964).

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B. INDUSTRIAL REVOLUTION

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Chamberlin, Eric R. **The Awakening Giant: Britain in the Industrial Revolution** (London: B. T. Batsford, 1976).

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Trinder, Barrie S. **The Making of the Industrial Landscape** (London: J. M. Dent & Sons, Ltd., 1982).
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Weitzman, David. **Traces of the Past: A Field Guide to Industrial Archeology** (New York: Charles Scribner's Sons, 1980).

C. INDUSTRIALIZATION IN AMERICA, AND SOCIAL EFFECTS

Appleton, Nathan. **Introduction of the Power Loom and Origin of Lowell** (Lowell, Mass.: B. H. Penhallow, 1858).
Baskin, John. **New Burlington: The Life and Death of an American Village** (New York: W. Norton & Co., 1976).
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Marx, Leo. **The Machine in the Garden: Technology and the Pastoral Ideal in America** (New York: Oxford University Press, 1964).
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H. THE AUTOMOBILE

Arnold, Horace L., and Fay L. Faurote. **Ford Methods and the Ford Shops** (New York: Engineering Magazine, 1915; reprinted, New York: Arno Press, 1972).

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Dettelbach, Cynthia Golomb. **In the Driver's Seat: The Automobile in American Literature and Popular Culture** (Westport, Conn.: Greenwood Press, 1976).

Flink, James J. **The Car Culture** (Cambridge, Mass.: MIT Press, 1975).

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Rae, John B. **The American Automobile: A Brief History** (Chicago: University of Chicago Press, 1965).

Rae, John B. **The Road and the Car in American Life** (Cambridge, Mass.: MIT Press, 1971).
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I. CONSTRUCTION; CITIES

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Fitch, James M. **American Building: The Historical Forces that Shaped It** (Boston: Houghton Mifflin, 1966).
Gies, Joseph. **Bridges and Men** (New York: Doubleday & Co., 1963).
Jackson, Kenneth T. **Crabgrass Frontier: The Suburbanization of the United States** (New York: Oxford University Press, 1985).
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McKay, John P. **Tramways and Trolleys: The Rise of Urban Mass Transport in Europe** (Princeton, N.J.: Princeton University Press, 1976).
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Pugsley, Sir Alfred, ed. **The Works of Isambard Kingdom Brunel** (Bristol: Institute of Civil Engineering, University of Bristol, 1977).
Scott, Quinta, and Howard S. Miller. **The Eads Bridge: Photographic Essay** (Columbia: University of Missouri Press, 1979).
Trachtenberg, Alan. **Brooklyn Bridge: Fact and Symbol** (New York: Oxford University Press, 1965).
Werner, Sam Bass. **Streetcar Suburbs: The Process of Growth in Boston, 1870-1900** (Cambridge, Mass.: Harvard University Press, 1962).
Werner, Sam Bass. **The Urban Wilderness: History of the American City** (New York: Harper & Row, 1972).

J. WOMEN AND TECHNOLOGY

Baker, Elizabeth. **Technology and Woman's Work** (New York: Columbia University Press, 1964).
Dublin, Thomas. **Women at Work: The Transformation of Work and Community in Lowell, Mass. 1826-1860** (New York: Columbia University Press, 1979).
Greenwald, Maurine Weiner. **Women, War and Work: The Impact of World War I on Women Workers in the United States** (Westport, Conn.: Greenwood Press, 1981).
Pinchbeck, Ivy. **Women Workers and the Industrial Revolution, 1750-1850** (New York: Augustus M. Kelley, 1969).
Rothschild, Joan, ed. **Machina ex Dea: Feminist Perspectives on Technology** (New York: Pergamon Press, 1983).
Rothschild, Joan, ed. **Women, Technology and Innovation** (Oxford: Pergamon Press, 1982).
Trescott, Martha Moore, ed. **Dynamos and Virgins Revisited: Women and Technological Change in History** (Metuchen, N.J.: Scarecrow, 1979).
Zimmerman, Jan, ed. **The Technological Woman: Interfacing with Tomorrow** (New York: Praeger, 1983).

K. TECHNOLOGY IN THE HOME

Cooper, Grace R. **The Sewing Machine: Its Invention and Development** (Washington, D.C.: Smithsonian Institution Press, 1976).

Cowan, Ruth Schwartz. **More Work for Mother: The Ironies of Household Technology from the Open Hearth to the Microwave** (New York: Basic Books, 1983).

Giedion, Siegfried. **Mechanization Takes Command: A Contribution to Anonymous History** (New York: W. W. Norton, 1969).

Hayden, Dolores. **The Grand Domestic Revolution: A History of Feminist Design for American Homes, Neighborhoods and Cities** (Cambridge, Mass.: MIT Press, 1981).

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Lesly, Philip. **Everything and the Kitchen Sink: How the First Century of Industry Created Our First Century of Good Living** (New York: Farrar, Straus & Co., 1955).

Strasser, Susan. **Never Done: A History of American Housework** (New York: Pantheon Books, 1982).

L. AIR, SPACE, MILITARY TECHNOLOGY

Aron, Raymond. **The Century of Total War** (Garden City, N.Y.: Doubleday, 1954).

Constant, Edward W. **The Origins of the Turbojet Revolution** (Baltimore, Md.: Johns Hopkins University Press, 1980).

Corn, Joseph J. **The Winged Gospel: America's Romance with Aviation, 1900-1950** (Oxford: Oxford University Press, 1983).

Crouch, Tom D. **A Dream of Wings: Americans and the Airplane** (New York: W. W. Norton, 1981).

Ellis, John. **The Social History of the Machine Gun** (New York: Pantheon Books, 1975).

Horwitch, Mel. **Clipped Wings: The American SST Conflict** (Cambridge, Mass.: MIT Press, 1982).

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Logsdon, John. **The Decision to Go the Moon: Project Apollo and the National Interest** (Chicago: University of Chicago Press, 1976).

Melman, Seymour. **The Permanent War Economy: American Capitalism in Decline** (New York: Simon & Schuster, 1974).

Wolfe, Tom. **The Right Stuff** (New York: Farrar, Straus & Giroux, 1979).

M. ENERGY; NUCLEAR POWER; THE BOMB

Carlson, Richard C., Willis W. Harman, and Peter Schwartz. **Energy Futures, Human Values, and Lifestyles: A New Look at the Energy Crisis** (Boulder, Col.: Westview Press, 1982).

Commoner, Barry. **The Poverty of Power: Energy and the Economic Crisis** (New York: Alfred A. Knopf, 1976).

Del Sesto, Steven L. **Science, Politics and Controversy: Civilian Nuclear Power in the United States 1946-1974** (Boulder, Col.: Westview Press, 1979).

Hewlett, Richard G., and Oscar E. Anderson. **A History of the U.S. Atomic energy Commission**, 2 vols., (University Park: Pennsylvania State University Press, 1962-1969)

*v. 1: **The New World 1939-1946**

*v. 2: **Atomic Shield 1947-1952**

Jungk, Robert. **Brighter Than a Thousand Suns: A Personal History of the Atomic Scientists** (New York: Harcourt Brace, 1958).
Kranzberg, Melvin, Timothy A. Hall, and Jane L. Scheiber, eds., **Energy and the Way We Live: A Course by Newspaper Reader** (San Francisco, Calif.: Boyd & Fraser, 1980).
Shrader-Frechette, K. S. **Nuclear Power and Public Policy: The Social and Ethical Problems of Fission Technology** (Dordrecht, Netherlands: D. Reidel, 1980).
Stephenson, Lee, and George R. Zachar, eds. **Accidents Will Happen: The Case Against Nuclear Power** (New York: Harper & Row, 1979).

N. ELECTRONICS; RADIO, TELEVISION

Barnouw, Eric. **Tube of Plenty: The Evolution of American Television** (New York: Oxford University Press, 1975).
Barnouw, Eric. **A History of Broadcasting in the United States**, 3 vols., (New York: Oxford University Press, 1966-70).
Cantril, Hadley, and Gordon W. Allport. **The Psychology of Radio** (New York: Harper & Bros., 1935).
Comstock, George A., Marilyn Fisher, and George Lindsey, eds. **Television and Human Behavior: The Key Studies** (Santa Monica, Calif.: Rand Corporation, 1975).
Comstock, George A. **Television in America** (London: Sage Publications, 1980).
Forester, Tom, ed. **The Microelectronics Revolution: The Complete Guide to the New Technology and Its Impact on Society** (Cambridge, Mass.: MIT Press, 1981).
McLuhan, Marshall. **Understanding Media: The Extensions of Man** (New York: McGraw-Hill, 1964).
Withey, Stephen B., and Ronald P. Abeles, eds. **Television and Social Behavior: Beyond Violence and Children** (Hillsdale, N.J.: L. Erlbaum Associates, 1980).

O. COMPUTERS

Adams, J. Mack, and Douglas H. Hayden. **Social Effects of Computer Use and Misuse** (New York: John Wiley & Sons, 1976).
Braun, Ernest, and Stuart MacDonald. **Revolution in Miniature: The History and Impact of Semiconductor Electronics Re-Explored in an Updated and Revised Edition** (Cambridge: Cambridge University Press, 1982).
Bolter, J. David. **Turing's Man: Western Culture in the Computer Age** (Chapel Hill: University of North Carolina Press, 1984).
Dertouzos, Michael L., and Joel Moses, eds. **The Computer Age: A Twenty Year View** (Cambridge, Mass.: MIT Press, 1979).
Evans, Christopher. **The Micro Millennium** (New York: Viking, 1980).
Goldstine, Herman H. **The Computer: From Pascal to von Neumann** (Princeton, N.J.: Princeton University Press, 1972).
Hanson, Dirk. **The New Alchemists: Silicon Valley and the Microelectronics Revolution** (Boston: Little, Brown & Co., 1982).
Kidder, Tracy. **The Soul of a New Machine** (Boston: Little, Brown & Co., 1982).
Turkle, Sherry. **The Second Self: Computers and the Human Spirit** (New York: Simon & Schuster, 1984).

P. SOCIAL AND ECONOMIC IMPACT OF TECHNOLOGY: GENERAL AND CURRENT ISSUES

Bell, Daniel. **The Coming of Post-Industrial Society: A Venture in Social Forecasting** (New York: Basic Books, 1973).
Bellamy, Edward. **Looking Backward 2000-1887** (Boston: Houghton Mifflin Co., 1941) [first publ. Ticknor and Co., 1888].
Boorstin, Daniel J. **The Republic of Technology: Reflections On Our Future Community** (New York: Harper & Row, 1978).
Braun, Ernest. **Assessment of Technical Decisions: Case Studies** (Woburn, Mass.: Butterworth Publications, 1979).

Ellul, Jacques. **The Technological Society** (New York: Alfred A. Knopf, 1964).
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Florman, Samuel C. **Blaming Technology: The Irrational Search for Scapegoats** (New York: St. Martin's Press, 1981).
Florman, Samuel C. **The Existential Pleasures of Engineering** (New York: St. Martin's Press, 1976).
Galbraith, John Kenneth. **The New Industrial State** (Boston: Houghton Mifflin Co., 2nd ed., 1971).
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Hillegas, Mark. **The Future as Nightmare: H. G. Wells and The Anti-Utopians** (New York: Oxford University Press, 1967).
Marcuse, Herbert. **One Dimensional Man: Studies in the Ideology of Advanced Industrial Society** (Boston: Beacon Press, 1964).
Pacey, Arnold. **The Culture of Technology** (Cambridge, Mass.: MIT Press, 1983).
Rosenberg, Nathan. **Technology and American Economic Growth** (New York: Harper & Row, 1972).
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Shumacher, Ernest F. **Small is Beautiful: Economics as if People Mattered** (New York: Harper & Row, 1973).
Spengler, Oswald. **Man and Technics: A Contribution to a Philosophy of Life**, transl. from the German by Charles F. Atkinson (Westport, Conn.: Greenwood Press, 1976) [first published as **Der Mench und die Technik** (Munich: C. H. Bech'sche Verlagsbuchhandlung, 1931)].
Toffler, Alvin. **The Third Wave** (New York: William Morrow & Co., 1980).
Winner, Langdon. **Autonomous Technology: Technics-out-of-Control as a Theme in Political Thought** (Cambridge, Mass.: MIT Press, 1977).

HISTORY OF SCIENCE AND TECHNOLOGY

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INTRODUCTION

In mid-20th century America, people tended to think that we had superior knowledge of, and command over, nature, and that we were better off for it. Consequently, studying the history of our science and technology seemed silly, an exercise in learning about the mistaken ideas our ancestors had. Recent scholarship, however, reveals a far more complex story. It turns out that the manner by which a society perceives of and manipulates nature is by no means determined entirely by physical laws or human instinct. Consequently, one must study the history of each civilization to understand how its systems of natural knowledge and material culture have evolved. Furthermore, the development of science and technology in a society can produce subtle and unsuspected results. Examination of these issues challenges the student's resourcefulness and encourages self-scrutiny.

This course is designed as a first excursion into the history of science and technology in Western civilization. Although it touches on many of the main episodes in that history, it is not a survey. Rather, it is an initiation into the subject. It aims, first, to awaken you to the insights you can find in this scholarship; second, to familiarize you with the major contours of the scholarly literature; third, to outline the development of Western science and technology since the Middle Ages; and fourth, to sharpen your critical perspectives on current science and technology. STS majors wishing to specialize in historical studies may use this as a springboard to more advanced work. Other undergraduates will find that this course will deepen their understanding of their chosen professions and encourage mature judgments concerning the courses their careers take.

TEXTS

Required

Edward H. Carr, **What is History?** (New York: Random House, Vintage, 1957).

James Deetz, **In Small Things Forgotten: The Archaeology of Early American Life** (Garden City, N.Y.: Doubleday, Anchor Books, 1977).

P.M. Harman, **The Scientific Revolution** (London and New York: Methuen, Lancaster Pamphlets, 1983).

Daniel J. Kevles, **The Physicists: The History of a Scientific Community in Modern America** (New York: Random House, Vintage Book, 1979).

Arnold Pacey, **The Maze of Ingenuity: Ideas and Idealism in the Development of Technology** (Cambridge, Mass.: MIT Press, 1976).

Carroll W. Pursell, Jr., ed., **Technology in America: A History of Individuals and Ideas** (Cambridge, Mass.: MIT Press, 1981).

Recommended (strongly so for STS majors)

William F. Bynum, et al., eds., **Dictionary of the History of Science** (Princeton, N.J.: Princeton University Press, 1985).

Paul T. Durbin, ed., **A Guide to the Culture of Science, Technology, and Medicine** (New York: Free Press, 1984).

ASSIGNMENTS AND GRADES

The grade in this course will derive from six different indicators of your performance: the higher two grades from three short surprise quizzes on the readings; a four-page essay; a midterm; a final; and class participation (which will include special preparation for one discussion class, plus weekly ungraded written reflections.)

Unless the class as a whole is not at all average, grading will be adjusted to a normal curve with a mean of B-minus. Cheating on any part of the course will constitute grounds for failure of the whole course. Weighting of the various components of the grade will be as follows:

Top Two Quiz Scores	10% each
Four-Page Essay	15
Midterm Examination	20
Final Examination	25
Class Participation	20

The three quizzes will be given in class on unannounced dates. They will be simple tests of your diligence in keeping up with and comprehending the assigned readings. Only the better two of your three scores will be counted toward your grade. The essay, a four-page typed discussion of one of the class sessions, will serve as an exercise in analytical prose and critical thought. One of four possible due dates will be assigned randomly to each student. The midterm and the final will be more strenuous tests of your ability too integrate the materials of the course into your own critical historical interpretation. They will be in-class, open-notes, closed-book essay exams. (If a majority of the class wishes it, the final will be handed out in advance.) The best preparation for the exams is full and responsible participation in class discussions, which provide an opportunity to subject your ideas to public scrutiny. This is such an important element of history that class participation is factored materially into the grade. The instructor will be the discussion leader, but once during the semester, each student will help the instructor direct the class discussion by being an agent provocateur. (A sign-up sheet for these assignments will be available on the second day of class.) The success of the course depends critically upon each student attending class religiously, completing the readings before class, and participating actively in discussions.

Students are also required to submit a page of reflections on the readings at the beginning of each discussion, and to write an anonymous one-paragraph evaluation of the week's work at the end of that discussion. The number of one-page reflections submitted will be factored into the class participation grade, but the reflections themselves will not be graded; they provide writing practice for the student and allow the instructor to monitor progress in the course.

The instructor's current areas of research involve the development of Ph.D. programs in chemistry and chemical engineering, the careers of doctorate chemists

and chemical engineers, and the history of RPI as a place where science has been done. All students are encouraged to try their hands at original research--even to propose a research project in lieu of the midterm and final. If the class wishes, the latter part of the course may be converted into an undergraduate research seminar. In addition, the instructor welcomes proposals for extra credit work of other sorts.

This course may be taken for social sciences credit. It is also a required course for STS majors specializing in historical studies.

COURSE SCHEDULE
[This semester-length course meets bi-weekly, Editor]

Most of the semester will consist of two-class units. In the first class of each unit, the instructor will offer supplementary information and illustrations, then tease out the major themes for discussion. You will be the major actors for the discussion classes. At the end of each discussion, the instructor will briefly introduce the topic for the upcoming week.

1. Organizational Meeting: Definitions and Objectives

2-3. What Is History?
Reading: Carr, **What is History?**, ch. 1 and 4.
"Prologue: The Strange Death of Silas Deane," in James West Davidson and Mark Hamilton Lytle, **After the Fact: The Art of Historical Detection** (New York: Knopf, 1982), pp. xiii-xxxii.

4-5. A Sampler of Curiosities
Reading: Lynn White, Jr., "Death and the Devil," in Robert S. Kinsman, ed., **The Darker Vision of the Renaissance** (Berkeley: University of California Press, 1974), pp. 25-46.
Robert Darnton, "Workers Revolt: The Great Cat Massacre of the Rue Saint-Severin," in **The Great Cat Massacre and Other Episodes in French Cultural History** (New York: Random House, Vintage Books, 1985), pp. 74-104.
J. Bronowski, "Knowledge or Certainty," in **The Ascent of Man** (Boston: Little, Brown and Company, 1973), pp. 352-377.

6-7. Historiography of Science and Technology
Reading: Thomas S. Kuhn, "The History of Science," in **The Essential Tension: Selected Studies in Scientific Tradition and Change** (Chicago: University of Chicago Press, 1977), pp. 105-126.
Arnold Thackray, "History of Science in the 1980s: Science, Technology, and Medicine," **Journal of Interdisciplinary History** 12 (Autumn 1981): 299-314.
John M. Staudenmaier, **Technology's Storytellers: Reweaving the Human Fabric** (Cambridge, Mass.: MIT Press, 1985), ch. 1, pp. 1-34.

Recommended: browse in Bynum, **Dictionary**, and in Durbin, **Guide** (esp. the chapter by Thackray).

8-9. Medieval Technology and the Medieval World-View
Note: Group 1 essays due at end of this unit
Reading: Pacey, **Maze of Ingenuity**, Preface, pp. 13-21 ("Introduction"), and ch. 1-2, pp. 25-86.

10-11. Scientific Revolution I: The Italian Renaissance
Reading: Harman, **Scientific Revolution**, entire.
Richard S. Westfall, "Science and Patronage: Galileo and the Telescope," **Isis** 76 (March 1985): 11-30.

12-13. Scientific Revolution II: The English Civil War
Note: Group 2 essays due at end of this unit
Reading: Charles Webster, "Conclusions: The Puritan World View and the Rise of Modern Science," in **The Great Instauration: Science, Medicine and Reform, 1626-1660** (London: Gerald Duckworth & Co., Ltd., 1975), pp. 484-520.
Carolyn Merchant, **The Death of Nature: Women, Ecology, and the Scientific Revolution** (New York: Harper & Row, 1980), ch. 12.

14-17. Early American Science and Technology
Note: Midterm examination (open notes) in class 15
Instructor out of town for class 16; dig in library
Reading: Deetz, **Small Things Forgotten**, ch. 1, 4-5, pp. 2-25, 64-119.
Pursell, **Technology in America**, ch. 2-3, pp. 8-33.

18-19. Industrial Revolution
Note: Group 3 essays due at end of this unit
Reading: James Burke, "Credit Where It's Due," in **The Day the Universe Changed** (London: British Broadcasting Corp., 1985), pp. 162-193.
Ray Porter, "The Industrial Revolution and the Rise of the Science of Geology," in Mikuláš Teich and Robert Young, eds., **Changing Perspectives in the History of Science: Essays in Honour of Joseph Needham** (London: Heinemann, 1973), pp. 320-343.
Pacey, **Maze of Ingenuity**, ch. 7-8, pp. 204-261.

20-21. American Science and Technology Transformed
Reading: P. Thomas Carroll, "American Science Transformed," **American Scientist** 14 (Sept.-Oct. 1986): 466-485.
Pursell, **Technology in America**, ch. 5 and 7, pp. 45-61, 71-79.
Kevles, **The Physicists**, ch. 1-5, pp. 3-74.

22-23. The Second Industrial Revolution
Note: Group 4 essays due at end of this unit
Reading: Pursell, **Technology in America**, ch. 11-12, pp. 117-141.
Kevles, **The Physicists**, ch. 7, pp. 91-101.
John J. Beer, "Coal Tar Dye Manufacture and the Origins of the Modern Industrial Research Laboratory," **Isis** 49 (June 1958): 123-131.

24-25. Scientific Age I: Conceptual Upheavals

Reading: Paul Forman, "Weimar Culture, Causality, and Quantum Theory, 1918-1927: Adaptation by German Physicists and Mathematicians to a Hostile Intellectual Environment," **Historical Studies in the Physical Sciences** 3 (1971): 1-115.

Kevles, **The Physicists**, ch. 6, 11, 15, pp. 75-90, 155-169, 222-235.

26. Thanksgiving Holiday

Find out what your relatives believe about nature, and study the messages in their artifacts.

27-28. Scientific Age II: Big Science and Other Institutional Novelties

Reading: Derek J. de Solla Price, **Little Science, Big Science** (New York: Columbia University Press, 1963), ch. 1 and 3, pp. 1-32, 62-91.

Kevles, **The Physicists**, ch. 21-23, pp. 324-392.

Bernard Taper, "The Bittersweet Harvest," **Science 80** 1 (November 1980): 78-84.

29-30. Review for Final Exam

SECTION I: TECHNOLOGY IN HISTORY

Part 2: Technology in American History

TECHNOLOGY AND SOCIETY IN AMERICA

Leonard S. Reich
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INTRODUCTION

Technology seems to dominate our civilization. From autos, airplanes, and television, to nuclear power, industrial robots, high-tech medicine, insecticides, and electric hair dryers, we are surrounded -- some would say controlled -- by the discoveries and inventions of the last two centuries. Significantly, America took form as a nation just at the time of the Industrial Revolution, when mechanical power replaced animal power and the pace of production and innovation increased tremendously. Largely unfettered by pre-industrial laws and traditions (unlike the European countries), the United States thus became the world's first technological society.

In this course we will study the processes by which the rapid technological developments took place. We will be concerned with the country's transformation from an agricultural- to an industrial-based economy during the 19th century; with the stimuli and constraints on inventors, engineers, entrepreneurs, and corporations; with the hesitant and often ineffective attempts by government to control technology; and with the impact that evolving technology and industry have had on the lives of all the nation's people.

This is not an easy task. The subject matter is so large and diverse that no set of readings and lectures can address all pertinent topics and questions. At best, a basis can be laid for further study. It is hoped, then, that this course will provide the "take off" for each student's consideration of how technology fits into American civilization and how it affects his or her own life. In making such an on-going study, each person can better adjust his or her relationship to technology and can act intelligently to have an influence on that relationship, whether on a personal or institutional level.

COURSE ORGANIZATION

The course will be largely reading-discussion, with a few lectures and several videotape presentations. Readings will be assigned on a regular basis for class discussion. Be sure that you have carefully read all assigned materials before class time, since what you can contribute and what you can get out of class discussions will be determined in large part by the knowledge you bring in with you. Note also that a substantial portion of your final grade in the course will be based on your preparation for and participation in these discussions.

GRADING

There will be no hourly examinations. Instead, you will be given three take-home questions to be completed during the semester. They will be assigned in class and due a week later. (See class schedule.) Each of the questions is to be answered

in 500-1000 words and should be carefully thought-out and concisely written. Students who have problems writing essays are encouraged to consult with the instructor to improve their presentation. These take-home questions are to be strictly individual efforts and will be graded down if late unless arrangements are made before they are due. There will be a course final examination consisting of essay questions.

Your course grade will be determined as follows:

Three take-home essays	51% (17% each)
Preparation and participation	24%
Final examination	25%

TEXTS

The following books are available at the College bookstore and should be purchased for the course:

John Kasson, **Civilizing the Machine** (New York: Grossman Publishers, 1976)
Matthew Josephson, **Edison: A Biography** (New York: McGraw-Hill, 1959)

In addition to materials out of these books, a number of articles and book chapters will be made available as photocopies, to be purchased either from the instructor or the bookstore.

CLASS SCHEDULE
[This semester-length course meets bi-weekly, Editor]

1. Introduction: Defining Technology

2. The Purposes of Technology
   Charles Rosenberg, "Technology, Economy, and Values" in Carl Mitcham and Robert MacKey, eds., **Philosophy and Technology** (New York: Free Press, 1972), pp. 81-105.
   Colin Norman, **The God that Limps** (New York: W. W. Norton, 1981), pp. 15-26.

3. Ideology and Technology - Republicanism
   Kasson, **Civilizing the Machine**, ch. 1, pp. 1-52.

4. The Lowell Mills
   Kasson, **Civilizing the Machine**, ch. 2, pp. 53-106.

5. The American System of Manufactures/Government and The Control of Technology/Development of Early American Technology
   M. Roe Smith, "Eli Whitney and the American System of Manufacturing" in Carroll Pursell, ed., **Technology in America: A History of Individuals and Ideas** (Cambridge, Mass.: MIT Press, 1981), pp. 45-61.
   John Burke, "Bursting Boilers and the Federal Power," **Technology and Culture** 7 (Jan. 1966): 1-23.

Nathan Rosenberg, "The Nineteenth Century: America as Initiator," in Rosenberg, **Technology and American Economic Growth** (New York: Harper & Row, 1972), pp. 97-116.

6. Lecture on Canals and Railroads
   FIRST TAKE-HOME QUESTION

7. The Heroic Inventor & The Beginnings of Organized Research
   Josephson, **Edison**, pp. 1-174.

8. Field trip to "Made in Maine" exhibit, State Museum, Augusta

9. Electric Light and Power
   Josephson, **Edison**, pp. 175-290, 339-366.

10. Technology and Urbanization
    Samuel Bass Warner, **Streetcar Suburbs** (Cambridge, Mass.: Harvard University Press, 1978), ch. 1-2, pp. 1-34.
    Daniel Boorstin, **The Americans The Democratic Experience** (New York: Vintage, 1974), pp. 101-109, 261-273.

11. Technology and Agriculture
    Reynold Wik, "The Government and Agricultural Technology" in John Burke and Marshall Eakin, eds., **Technology and Change** (San Francisco: Boyd and Fraser, 1979), pp. 338-347.
    Maisie and Richard Conrat, "How American Farmers Became Specialists -- In Cash and in Debts," **Smithsonian Magazine** 7 (March 1977): 48-54.

12. VIDEOTAPE on American farming [Nova Series]

13. Workers, Organizations, and Technology
    SECOND TAKE-HOME QUESTION
    John Rae, "The Rationalization of Production," in Melvin Kranzberg and Carroll Pursell, eds., **Technology in Western Civilization**, v. 2 (New York: Oxford University Press, 1967), pp. 37-51.
    Robert Guest, "The Rationalization of Management," in **Ibid.**, pp. 52-63.

14. Lecture on Research, Development, and the Rise of Large Corporations

15. The Automobile
    Richard Harmond, "Americans and the Automobile," in Frank Coppa and Richard Harmond, eds, **Technology in the Twentieth Century** (Debuque, Iowa: Kendall/Hunt, 1983), pp. 89-109.
    James Flink, "Three Stages of American Automobile Consciousness," **American Quarterly** 24 (Oct. 1972): 451-473.

16. Technology and The "Consumer"
    Ruth Cowan, "The `Industrial Revolution' in the Home: Household Technology and Social Change in the 20th Century," **Technology and Culture** 17 (Jan. 1976): 1-23.
    Susan Kleinberg, "Women and Housework", in Coppa and Hammonds, eds., **Technology in the Twentieth Century**, pp. 1-24.

17. VIDEOTAPE on the DC-3 and Commercial Aviation [Nova Series]

18. Technology and the Environment
    Joseph Pratt, "Letting the Grandchildren Do It: Environmental Planning During the Ascent of Oil as a Major Energy Source," **The Public Historian** 2 (Summer 1980): 28-61.
    "A Problem that Cannot be Buried," **Time** (Oct. 14, 1985): 76-84.

19. VIDEOTAPE on Atmospheric Pollution [Nova Series]
    THIRD TAKE-HOME QUESTION

20. Big Business and Control of Technology
    Shoshana Zuboff, "New Worlds of Computer-Mediated Work," in Lynn Salerno, ed., **Catching Up with the Computer Revolution** (New York: Wiley, 1983), pp. 451-466.
    David Noble, "Social Choices in Machine Design," **Politics and Society** 8, no. 3-4 (1978): 313-347.

21. VIDEOTAPE on Factory Automation [Nova Series]

22. The Mass Media
    Paul Hirsh, "The Role of Television and Popular Culture in Contemporary Society," in Horace Newcomb, ed., **Television: The Critical View**, 2nd ed., (New York: Oxford University Press, 1979), pp. 249-279.
    Loring Mandel, "Network TV," **Parade Magazine** (May 11, 1986).

23. Government Promotion and Control -- Atomic Energy
    Daniel Ford, "The Cult of the Atom," **The New Yorker** 58 (Oct. 25, 1982): 107-159.
    Langdon Winner, "Energy Regimes and the Ideology of Efficiency," in George Daniels and Mark Rose, eds., **Energy and Transport** (Beverly Hills, Calif.: Sage, 1982), pp. 261-277.

24. VIDEOTAPE on Alternative Energy Sources

25. Conclusion
    E. F Schumacher, **Small is Beautiful: Economics as if People Mattered** (New York: Harper & Row, 1973), pp. 12-49, 138-151.

THE MACHINE IN AMERICA

Roger Simon
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INTRODUCTION

This course is a survey of the history of technology in the United States since the colonial period. The theme that will be developed is that technological change is a social process which derives from the needs and priorities of the society. The objectives of the course are to provide the student with an understanding of the interaction between society's values and priorities and the technological changes occurring since the 17th century. The course will examine in some depth the impact of technological changes on the work process, the workers, the economy, and the consuming public. It is also a major objective of the course to improve the student's ability to communicate clearly and to analyze and synthesize historical material.

COURSE REQUIREMENTS

This will primarily be a lecture course, but questions are welcome at any time during class. In addition, there will be several periods during the term set aside specifically for discussion of major reading assignments. Students are expected to be prepared to discuss the designated readings at those sessions. Attendance will be taken at all classes and students with an excessive number of absences will be penalized. Absence from a discussion class will be counted as a "double cut."

There will be two hour-examinations during the term on the dates indicated. Each exam will cover the material since the previous exam. Students may write a paper for extra credit (optional). The final examination will draw on material from the entire course. There are no exemptions from the final; the final will only be given at the time and place scheduled by the registrar. The final grade will be weighted as follows: each hour exam, 30%; final exam, 40%. Students whose average is on the borderline will receive the benefit of the doubt if their work has shown improvement and if their attendance is good.

EXTRA CREDIT (Optional)

There are two types of extra credit projects possible. One is to write an essay (4-5 typed pages) on a book selected from a bibliography available from me. The paper must relate the principal findings of the book to the themes of the course. The other type of project is to conduct an interview with an older person about how technology has changed in their lifetime and affected their life. The interview must be tape-recorded and the tape submitted with a paper of 4-5 typed pages which discusses the most important points of the interview. Students may do one paper of each type, or up to two papers on the books. I have a guide-sheet for doing this type of paper.

REQUIRED TEXTS (all available in paperback)

Daniel Boorstin, **The Americans: The Democratic Experience** (New York: Vintage, 1974).
R. L. Heilbroner and A. Singer, **The Economic Transformation of America: 1600 to the Present**, 2nd ed., (New York: Harcourt, Brace, Jovanovich, 1984).
Daniel Nelson, **Managers and Workers** (Madison: University of Wisconsin Press, 1975).
Carroll W. Pursell, ed., **Technology in America** (Cambridge, Mass.: MIT Press, 1981).
Merritt Roe Smith, **Harpers Ferry Armory and the New Technology** (Ithaca: Cornell University Press, 1977).
[Note: I previously used Tom Wolfe, **The Right Stuff** (New York: Bantam, 1980) as the last book of the course, but have dropped it because too many students were renting the movie video instead of reading the book.]

CLASS SCHEDULE AND ASSIGNMENTS
[This semester-length course meets tri-weekly, Editor]

1. Introduction. Settlement of America.

2. Tools and Technology in Pre-Industrial America
   Heilbroner, **Economic Transformation**, ch. 1-3, pp. 3-49.
   Pursell, **Technology in America**, ch. 2, pp. 8-16.

3. Energy Sources and Use in Pre-Industrial America
   [Film: **Mill at Philipsburg Manor**, Sleepy Hollow Restoration, Tarrytown, NY]
   Pursell, **Technology in America**, ch. 3, pp. 17-33.

4. Industrialization Picks Up Steam
   Pursell, **Technology in America**, ch. 4, pp. 34-44.

5. Conquest of Space: Canals and Steamboats
   Heilbroner, **Economic Transformation**, pp. 89-97.

6. Conquest of Space: Railroads
   Heilbroner, **Economic Transformation**, pp. 97-100.

7. Making Cloth by Hand and the Antecedents of Industrialization
   Heilbroner, **Economic Transformation**, ch. 4-5, pp. 51-87.

8. The First Factories: Slater and Lowell

9. The Unique Lowell Work Force
   Heilbroner, **Economic Transformation**, pp. 101-108.

10. The Craft Tradition and the Technical and Social Problems of Interchangeable Parts
    [Film: **Gunsmith of Williamsburg**, only first half shown, available on 16mm or video cassette from Colonial Williamsburg, Inc.]
    Heilbroner, **Economic Transformation**, pp. 108-115.
    Smith, **Harpers Ferry Armory**, Introduction, ch. 1-5, pp. 17-139.

11. Origins of the American System of Manufactures and the Development of Machine Tools
Smith, **Harpers Ferry Armory**, ch. 6-9 and 11, pp. 140-304 and 323-335.

12. CLASS DISCUSSION: Students are to be prepared to discuss the assignments of classes 10 and 11

13. Technical Knowledge and the Education of Engineers
Pursell, **Technology in America**, ch. 6, pp. 62-70.
Boorstin, **The Americans**, pp. 478-490.

14. FIRST HOUR EXAM

15. The Mechanization of Agriculture
Pursell, **Technology in America**, ch. 7, pp. 71-79.

16. Coal and Iron

17. Steel
Heilbroner, **Economic Transformation**, pp. 169-178.
Pursell, **Technology in America**, ch. 8, pp. 80-91.

18. Industrialization and Economic Change
Heilbroner, **Economic Transformation**, ch. 7-8, pp. 117-167.

19. Electricity, Communications, and Research
Pursell, **Technology in America**, ch. 10-12, pp. 105-141.
Boorstin, **The Americans**, pp. 525-546.

20. Technology and the Modern Corporation
Heilbroner, **Economic Transformation**, pp. 178-191 and ch. 10, pp. 193-217.
Boorstin, **The Americans**, pp. 41-52, 148-156, 411-412, 434-447.

21. The Mass Consumption Society
Boorstin, **The Americans**, pp. 1, 89-148, 188-205, 305-358.
CLASS DISCUSSION: Students are expected to be prepared to discuss the assignments for classes 20 and 21.

22. Technological Change and the Cities
[Film: **The Brooklyn Bridge**, part I only, from Direct Cinema, P.O. Box 69589, Los Angeles, CA 90069]
Boorstin, **The Americans**, pp. 245-252, 261-267.
Heilbroner, **Economic Transformation**, pp. 249-261.

23. Workers, Working Conditions, and Unions: 19th Century
Heilbroner, **Economic Transformation**, pp. 219-230, 232-247.

24. SECOND HOUR EXAM

25. An Overview of the Twentieth Century
Heilbroner, **Economic Transformation**, pp. 271-287, 293-353.
Pursell, **Technology in America**, ch. 16 and 18, pp. 176-191 and 202-212.

26. Scientific Management and Assembly Line
    [Film: **Clockwork**, from California Newsreel, 630 Natoma St., San Francisco, CA 94103]
    Nelson, **Managers and Workers**, Preface and ch. 1-4, pp. ix-x and pp. 3-78.
    Boorstin, **The Americans**, pp. 361-370.

27. Workers and Unions in 20th Century
    Nelson, **Managers and Workers**, ch. 5 and Epilogue, pp. 79-100 and pp. 163-164.

28. CLASS DISCUSSION: Students are to be prepared to discuss the assignments of classes 26 and 27

29. Introduction of the Automobile
    [Film: **The Road to Happiness: The Life and Times of Henry Ford**, from Films, Inc., 1144 Wilmette Ave., Wilmette, Ill.]
    Boorstin, **The Americans**, pp. 57-62.
    Pursell, **Technology in America**, ch. 15, pp. 163-175.

30. America's "Love Affair" with the Automobile
    Boorstin, **The Americans**, pp. 525-526, 546-555.

31. The Car, the City, and the Suburb
    Boorstin, **The Americans**, pp. 267-272.

32. The Role of Women and Housework: 19th Century
    Pursell, **Technology in America**, ch. 13, pp. 142-150.
    Heilbroner, **Economic Transformation**, pp. 230-232, 261-263.

33. Role of Women and Home Appliances: 20th Century

34. Technology and Leisure: Amusement Parks and Movies
    Pursell, **Technology in America**, ch. 17, pp. 192-201.

35. Radio
    Boorstin, **The Americans**, pp. 470-477.

36. Television
    Boorstin, **The Americans**, pp. 386-397.

37. CLASS DISCUSSION: Students are to be prepared to discuss the assignments for classes 29-36

38. The Military-Industrial Complex and the Space Program
    Pursell, **Technology in America**, ch. 19-20, pp. 213-240.

39. Nuclear Electric Power

40. Computers: Applications and Implications

41. Conclusions

BIBLIOGRAPHY AND SUPPLEMENTARY READINGS

Reference Books

The reference books are intended for students interested in some additional reading on a particular topic or for students who miss a lecture and want a brief review of the topic covered. (All these books are on reserve at the Fairchild Library.) These volumes contain short essays or chapters dealing with specific technologies. If you are interested in a little more detail on how a specific technology works or operates, they are particularly useful sources.

Derry, T. K., and Trevor I. Williams. **A Short History of Technology** (London: Oxford University Press, 1960.

Kranzberg, Melvin, and Carroll Pursell, eds. **Technology in Western Civilization**, 2 vols., (New York: Oxford, 1967). Chapter-length essays; first volume deals primarily with 18th and 19th centuries; second volume with 20th century.

Singer, Charles J., **et al.**, eds. **A History of Technology**, 5 vols., (Oxford: Oxford University Press, 1954-1958). Vol. 3 covers 1500-1750; vol. 4 1750-1850; vol. 5, 1850-1900. Heavy emphasis on British and European developments.

Usher, Abbott P. **History of Mechanical Inventions** (Cambridge, Mass.: Harvard University Press, 1954).

Williams, Trevor, ed. **A History of Technology**, 2 vols., (Oxford: Clarendon, 1978). Continues Singer's series down to 1950.

Studies of Specific Topics for Extra Credit Papers or Additional Readings. (Students interested in topics not on the list should see Dr. Simon for suggestions. Students doing extra credit papers must have prior approval for any books not on this list.)

General Works

Hindle, Brooke. **Emulation and Invention** (New York: New York Univ. Press, 1981).

Kasson, John. **Civilizing the Machine** (New York: Penguin, 1977)

Marx, Leo. **The Machine in the Garden** (New York: Oxford University Press, 1964)

Morison, Elting. **From Know-How to Nowhere** (New York: Mentor, 1974)

Pre-Industrial America

Hindle, Brooke, ed. **America's Wooden Age** (Tarrytown, N.Y.: Sleepy Hollow Restorations, 1975).

Hunter, Louis. **Waterpower in the Century of the Steam Engine** (Charlottesville, Virg.: University of Virginia, 1979).

York, Neil L. **Mechanical Metamorphosis** (Westport, Conn.: Greenwood, 1985).

Textiles and the First Factories

Dublin, Thomas. **Women at Work** (New York: Columbia University, 1979).

Jeremy, David. **Transatlantic Industrial Revolution** (Cambridge, Mass.: MIT Press, 1981).

Prude, Jonathan. **The Coming of Industrial Order** (New York: Cambridge University, 1983).

Wallace, Anthony. **Rochdale** (New York: Knopf, 1978), parts I and II.

Steam Engine and Railroads

Mazlish, Bruce, ed. **The Railroad and the Space Program** (Cambridge, Mass.: MIT Press, 1965).
Pursell, Carroll. **Early Stationary Steam Engines in America** (Washington: Smithsonian Institution, 1969).
Taylor, George R. **Transportation Revolution** (New York: Holt, Rinehart & Winston, 1962).
Taylor, George R., and Irene Neu. **American Railroad Network** (Cambridge, Mass.: Harvard, 1956).

Machine Tools and the "American System"

Hounshell, David. **From the American System to Mass Production** (Baltimore: Johns Hopkins, 1984).
Mayr, Otto, and Robert C. Post, eds. **Yankee Enterprise** (Washington: Smithsonian Institution, 1981).

Technology as Knowledge and Engineering Profession

Calhoun, Daniel H. **The American Civil Engineer** (Cambridge, Mass.: MIT Press, 1960).
Calvert, Monte. **The Mechanical Engineer in America** (Baltimore: Johns Hopkins, 1967).
Layton, Edwin T., Jr. **The Revolt of the Engineers** (Cleveland: Press of Case Western Reserve University, 1971; reprinted Baltimore: Johns Hopkins, 1956).
McMahon, A. Michael. **The Making of a Profession: A Century of Electrical Engineering** (New York: IEEE Press, 1984).
Reynolds, Terry S. **75 Years of Progress: A History of the American Institute of Chemical Engineers** (New York: AIChE, 1983).
Sinclair, Bruce. **A Centennial History of the American Society of Mechanical Engineers** (Toronto: University of Toronto Press, 1980).

Iron and Steel

Brody, David. **Steel-Workers in America: The Non-Union Era** (Cambridge, Mass.: Harvard, 1960).
Hogan, William T. **Economic History of the Iron and Steel Industry**, 5 vols. (Lexington, Mass.: D.C. Heath, 1971).
McHugh, Jeanne. **Alexander Holley** (Baltimore: Johns Hopkins, 1980).
Temin, Peter. **Iron and Steel in Nineteenth-Century America** (Cambridge, Mass.: MIT Press, 1964).

Skyscrapers, Bridges, and Cities

Billington, David. **The Tower and the Bridge** (New York: Basic Books, 1983).
Condit, Carl. **American Building Art: The Nineteenth Century** (New York: Oxford, 1960).

McCullough, David. **The Great Bridge** (New York: Simon and Schuster, 1972).
McCullough, David. **The Path Between the Seas** (New York: Simon and Schuster, 1977).
Warner, Sam Bass Jr. **Streetcar Suburbs** (Cambridge, Mass.: Harvard, 1962).

Corporations and Business

Chandler, Alfred D. **The Visible Hand** (Cambridge, Mass.: Belknap Press, 1977).
Chandler, Alfred D., and S. Salisbury. **Pierre S. duPont and the Making of the Modern Corporation** (New York: Harper & Row, 1971).
Cochran, Thomas. **Pabst Brewing Co.** (New York: New York University Press, 1948).
Hower, Ralph. **History of Macy's** (Cambridge, Mass.: Harvard, 1943).
Twyman, Robert. **History of Marshall Field & Co.** (Philadelphia: University of Pennsylvania, 1954).

Industrial Labor, Unions, and Immigrants

Bell, Thomas. **Out of This Furnace** (Boston: Little Brown, 1941; reprinted Pittsburgh: University of Pittsburgh, 1976).
Bernstein, Irving. **The Lean Years** (Boston: Houghton, Mifflin, 1960).
Bernstein, Irving. **The Turbulent Years** (Boston: Houghton, Mifflin, 1969).
Bodnar, J., R. Simon, and M. Weber. **Lives of Their Own** (Urbana, Ill.: University of Illinois Press, 1982).
Brody, David. **The Steelworkers: The Non-Union Era** (Cambridge, Mass.: Harvard University Press, 1960).
Ehrlich, Richard. **Immigrants in Industrial American** (Charlottesville, Virg.: University of Virginia Press, 1977).
Licht, Walter. **Working for the Railroad** (Princeton, N.J.: Princeton University Press, 1983).
Montgomery, David. **Workers' Control in America** (New York: Cambridge University, 1979).
Rodgers, Daniel T. **The Work Ethic in Industrial America** (Chicago: University of Chicago, 1978)

Electricity, Communications, and Research

Brooks, John. **Telephone: The First Hundred Years** (New York: Harper & Row, 1976).
Bruce, Robert. **Bell: Alexander Graham Bell and the Conquest of Solitude** (Boston: Little Brown, 1973).
Friedel, Robert, and Paul Israel. **Edison's Electric Light** (New Brunswick, N.J.: Rutgers University Press, 1985).
Hughes, Thomas P. **Networks of Power** (Baltimore: Johns Hopkins, 1983).
Josephson, Matthew. **Edison** (New York: McGraw Hill, 1959).
Reich, Leonard. **The Making of American Industrial Research** (Cambridge: Cambridge University Press, 1985).

Women and Household Technology

Cowan, Ruth Schwartz. **More Work for Mother** (New York: Basic Books, 1983).
Davies, Margery. **Woman's Place is at the Typewriter** (Philadelphia: Temple University Press, 1982).

Kessler-Harris, Alice. **Out to Work** (New York: Oxford, 1982).
Strasser, Susan. **Never Done: A History of American Housework** (New York: Pantheon, 1982).

Automobile

Belasco, Warren. **Americans on the Road** (Cambridge, Mass.: MIT Press, 1979).
Flink, James. **The Car Culture** (Cambridge, Mass.: MIT Press, 1973).
Foster, Mark. **From Streetcar to Superhighway** (Philadelphia: Temple University Press, 1981).
Leslie, Stuart. **Boss Kettering** (New York: Columbia University Press, 1983).
Rae, John B. **The American Automobile** (Chicago: University of Chicago, 1965).
Rothschild, Emma. **Paradise Lost: The Decline of the Auto-Industrial Age** (New York: Vintage, 1973).

Radio and Television

Aitken, Hugh G. J. **The Continuous Wave: Technology and American Radio, 1900-1932** (Princeton: Princeton University Press, 1985).
Aitken, Hugh G. J. **Syntony and Spark: The Origins of Radio,** (New York: Wiley, 1976)
Barnouw, Eric. **History of Broadcasting,** 3 vols., (New York: Oxford University Press, 1966-70).
Comstock, George. **Television in America** (Beverly Hills, Calif.: Sage, 1980).
Comstock, George, et al. **Television and Human Behavior** (New York: Columbia University Press, 1978).

Scientific Management

Aitken, Hugh G. J. **Taylorism at Watertown Arsenal** (Cambridge, Mass.: Harvard, 1960).
Noble, David. **Forces of Production** (New York: Oxford, 1986).
Taylor, Frederick W. **Principles of Scientific Management** (New York: Norton, 1967).

Computers

Goldstine, Herman H. **The Computer from Pascal to von Neumann** (Princeton: Princeton University Press, 1972).
Kidder, Tracy. **The Soul of a New Machine** (Boston: Little, Brown, 1981).
Stern, Nancy. **From ENIAC to UNIVAC** (Bedford, Mass.: Digital Press, 1981).

Manhattan Project

Hewlett, Richard, and Oscar Anderson. **The New World, 1939-1946** (volume 1 of **A History of the U.S. Atomic Energy Commission**) (University Park, Penn.: Pennsylvania State University Press, 1962).
Jungk, Robert. **Brighter Than a Thousand Suns** (New York: Harcourt, Brace, Jovanovich, 1958).

Nuclear Power and Energy

Kash, Don, and Robert Rycroft. **U.S. Energy Policy** (Norman: University of Oklahoma Press, 1984).
Singer, S. Fred, ed. **Energy** (San Fancisco: W.H. Freeman, 1979).
Vietor, Richard. **Energy Policy in America Since 1945** (New York: Cambridge University Press, 1984).
Williamson, H. F., **et al.** **The American Petroleum Industry**, 2 vols., (Evanston, Ill.: Northwestern University Press, 1959, 1963).

Space Program and Military-Industrial Complex

Horwitch, Mel. **Clipped Wings: The American SST Conflict** (Cambridge, Mass.: MIT Press, 1982).
Koppes, Clayton. **J.P.L. and the American Space Program** (New Haven, Conn.: Yale University Press, 1982).
Logsdon, John. **The Decision to Go to the Moon** (Chicago: University of Chicago Press, 1970).

Annotated Bibliography

(for additional references; on reserve at Fairchild Library)

Cutcliffe, Stephen, **et al.** **Technology and Values in American Civilization** (Detroit: Gale, 1980).

TECHNOLOGY IN AMERICA 1790 TO 1986

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COURSE GOALS

In this course we will study technology in America. If, at the end of the course, you can answer the following questions with intelligent positions based on historical evidence you have successfully handled the course:

1. When did a recognizable U.S. style of technology emerge?
2. How do specific technological systems reveal the tension between design-constraints and the cultural values, motives, and world views of their designers?
3. How has U.S. style evolved and what factors have influenced its evolution?
4. How does the momentum of a system -- once it becomes part of our style -- influence U.S. life and later U.S. technological decisions?
5. Who gains and who loses because of the design of a system?
6. Is the U.S. style in crisis today?

A NOTE ON THE WORD "STYLE"

The word "style" is elusive. That's on purpose. You will be encouraged to work out your own explanation of U.S. technological style. To do it you will have to integrate two ways of thinking that cannot be separated for mature historical interpretation. The two:

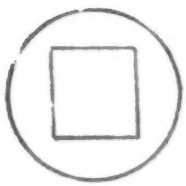
1. Specific data about a given technology:
   [Dates, people, events, design characteristics, etc.]
2. Interpretations of data:
   [What does the evidence mean?]

Do not leave data or interpretations out of your explanation. To spin out interpretations (about the meaning of some design or event) without thinking about the available evidence is just arm-chair theorizing. To simply list historical particulars without the hard labor of interpreting what they mean is to drive history into boredom, making it a list of "one damn thing after another."

When the course is over, it will be your own interpretation of America's changing technological style that will matter to you. You will hear of my interpretations and you will read those of other historians, but these are meant as helps and not as substitutes for your own thinking. After all, if our culture continues to survive, most of you will have about twenty years more time to live with our technological style than I probably will.

HOW TO INTERPRET A TECHNOLOGICAL SYSTEM

The diagram on the left helps demonstrate the two key dimensions of any technological system. The square is meant to indicate the technical design of the system. To understand any system you must ask yourself: "What are the necessary functional components of the system?" "How does it work?" [includes hardware, managerial structures, information loops, financial sources, etc.]



The circle indicates the context in which the system exists [includes the political, societal, aesthetic, moral, religious, cultural environment of the designers which influenced the way they designed the system, and it includes the social environment which is influenced by the system once it becomes successful].

In other words, no system can be understood apart from how it works and the specific historical situation in which it existed.

A NOTE ON HISTORICAL THINKING

Learning to think historically differs from learning a mathematical system or a language. A language is an already completed system that confronts you, the learner, as a whole. The "data" and "interpretations" are fixed in advance. To learn it you must submit yourself to that fixed system. The interpretations of historical evidence are not fixed. There are some intelligent interpretations already articulated by historians, but the work of interpretation is never finished. As a result, a better model for the kind of learning in this course is adult interaction with the evidence rather than submission to a fixed system.

THE IMPORTANCE OF CLASS PARTICIPATION

Historical learning is acquired intimacy. You get better at it the longer you work with a particular body of evidence. For that reason a high value will be placed on your participation in class discussions. When you think you have spotted a flaw in my -- or some other historian's -- interpretation, risk the argument. Whether you change your mind in the process or I change mine or we continue to disagree, we all learn by the attempt.

REQUIREMENTS AND GRADING

1. Weekly Quizzes: [40% of Final Grade]
Three questions on the week's readings. Note: the two brief essays for Greenfield Village will count as one quiz each. Note: When a quiz is missed due to late arrival it can be made up with a two-page essay summarizing the week's readings. For the first class missed, the same two-page essay make-up will be accepted. For any classes missed after one, a five-page essay on the themes and readings of the week (getting class notes from another student) will be required.

2. Two Essays: [20% of Final Grade]

Two essays [four page limit] will be due at the end of Weeks 6 and 11. For each essay you are to take one "theme" from the course and : (1) explain the theme in detail and (2) relate it to some contemporary technological issue from the newspaper (supply the article with your essay). (NB: Both essays take the place of a take-home midterm which I've dropped as too much work.)

3. Final Exam: [30% of Final Grade]

Standard written exam during finals week. Covers the entire course.

4. Class Participation: [10% of Final Grade]

I am an "old-fashioned" teacher in at least one sense. I use the 7-point grading scale instead of the 10-point scale. It makes little difference to you. In grading your work I am deciding whether I think your work merits an A, a B, a C, etc., and whether it should be a high A, a middle A, or a low A, etc. It is important that you remember what your number grades mean, however. The seven-point scale works like this.

100-93 = A 92-85 = B 84-77 = C 76-70 = D 69 and below = F

To help you remember I will always add the appropriate letter grade next to the number grade on your quizzes and papers.

Alternative Final Exam

For those students who have a B or better average at mid term and who would like more time to discuss course themes it is possible to substitute the following for the written final. One evening discussion (at my house, party setting) from 6:45-8:45 p.m. and an oral final during regular exam time. Students taking the oral final will automatically have a grade at least as good as the average of their quizzes and mid-term exam (i.e., if the oral grade is better than that average it will improve the grade, if it is less good or equal it will have no effect on your final grade). Some student will have to volunteer to arrange the two evening discussion dates.

Requirements & Grading for Students Taking for Graduate Credit

1. Weekly Quizzes: [25% of Grade]
2. Mid-Term: [25% of Grade]
3. Final: [25% of Grade]
4. Term Paper: [25% of Grade]

READINGS AND COSTS

The course requires one book:

James Flink, **The Car Culture** (Cambridge, Mass.: MIT Press, 1976 [$6.95].

The other readings are contained in a packet purchased from me [for around $20]. The only other cost is $6.00 for two trips to Greenfield Village.

COURSE OUTLINE

PART I: A DISTINCTLY "U.S." STYLE EMERGES: 1790-1880

WEEK 1 INTRODUCTION

Themes:

Emerging Technology -- The 3-Stage Model, Technological Momentum Model, The Middle Landscape and Early Transportation Systems [canals, roads]

Readings:

John M. Staudenmaier, "Hidden Assumptions in Technology Talk," **New Catholic World** 224 (May-June 1981): 104-107.

Elting E. Morison, "Building Things in Early America," and "The Works of John B. Jervis," in **From Know-How to Nowhere** (New York: Basic Books, 1974), pp. 16-71.

WEEK 2 TEXTILES: AN EARLY AMERICAN SYSTEM

[Note: Two quizzes this week to cover readings from Week 1 and Week 2]

Themes:

Middle Landscape vs. American Industrialization; Lowell mills during innovation boom period, Lowell's different constituencies; 3 historians' interpretations of Lowell; women's consciousness

Readings:

Norman B. Wilkinson, "Brandywine Borrowings from European Technology," **Technology and Culture** 4 (Jan. 1963): 1-13.

John F. Kasson, "The Factory as Republican Community: Lowell, Massachusetts," in **Civilizing the Machine** (New York: Penguin Books, 1976), ch. 2, pp. 53-106.

GREENFIELD VILLAGE, I [Saturday, 9:45-4:00]

On this tour we will look at a variety of technologies that are important during the early period of American technology: textiles (spinning, weaving), working metal (blacksmithing, machine tools), steam engines and factory belt-and-shaft power delivery, railroads. Note: A two-page essay, based on the museum visit, will be required.

Goals of the essay:

(1) observations on the sight and touch of early American technology
(2) how it is presented in the museum
(3) relate these two to what you've read about the history of technology

Note: Since this is a new venture for you the following policy will hold. I will grade the essays. If your second essay gets a better grade than this first one, you will be able to count both at the better grade. If the first essay gets the better grade, I will average the two grades.

WEEK 3 METAL & GOVERNMENT: STANDARDIZATION/REGULATION

Themes:

"Standardization" as the new American ideal; Military impact on technological style; technology transfer; labor-management conflict in standardization; the steamboat explosion controversy

Readings:

Merritt Roe Smith, "Army Ordnance and the 'American System' of Manufacturing, 1815-1861," in M.R. Smith, ed., **Military Enterprise and Technological Change** (Cambridge, Mass.: MIT Press, 1985), ch. 1, pp. 39-86.

John G. Burke, "Bursting Boilers & the Federal Power," **Technology and Culture** 7 (Jan. 1966) 1-23.

WEEK 4 FIRST NATIONAL SYNTHESIS: IRON, STEEL, RAILROADS

Themes:

Schon's model; "Risk vs. Uncertainty Thinking"; "Big Iron and Big Steel"; Railroads as a radically new transport system; Technological momentum.

Readings:

Elting E. Morison, "Almost the Greatest Invention," in **Men, Machines, and Modern Times** (Cambridge, Mass.: MIT Press), ch. 7, pp. 123-205.

Thomas C. Cochran, "The Social Impact of the Railroad," in Bruce Mazlish, ed., **The Railroad and the Space Program** (Cambridge, Mass.: MIT Press, 1965), pp. 163-181.

J. Lauritz Larson, "A Systems Approach to the History of Technology: An American Railroad Example," unpublished manuscript read at the October 1980 Society for the History of Technology Annual Meeting.

Carlene E. Stephens, **Inventing Standard Time** (Washington, D.C.: National Museum of American History, Smithsonian Institution, 1983).

WEEK 5 "PROGRESS": PROS AND CONS

Themes:

Worker culture vs. Factory systems; Optimism vs. Pessimism in US society generally; the Philly 1876 exposition; Montgomery Wards Catalog; Utopian and Dystopian novels

Readings:

Shoshanah Zuboff, "Work and Human Interaction in Historical Perspective," unpublished manuscript, Harvard Business School.

PART II: MIDDLE LANDSCAPE TO MELTING POT, 1880-1930

WEEK 6 ELECTRICITY'S DOMAIN, 1880-1915

Themes:

Edison and Inventive Method [Menlo Park as R&D laboratory]; Role of money in radically new technological emergence; load management and integration of a dynamic system

Readings:

Thomas P. Hughes, "The Electrification of American: The System Builders," **Technology and Culture** 20 (Jan. 1979): 124-161.

Pamela W. Lurito, "The Message Was Electric," **IEEE Spectrum** 21 (September 1984): 84-95.

WEEK 7 BIG BUSINESS AND THE MELTING POT

Themes:

Wave of business mergers; Engineers [employees or professionals?]; R&D within corporate control; Trist's model of systems analysis

Readings:

Alfred E. Chandler, "The Coming of Big Business," in C. Vann Woodward, ed., **The Comparative Approach to American History** (New York: Basic Books, 1968), pp. 220-237.

GREENFIELD VILLAGE, II [Saturday]

On this trip we will explore a number of technologies important for the second part of the course: electricity and early R&D laboratory (Menlo Park), automobiles (automobile collection), agriculture, advertising. Note: A two-page written assignment, based on the museum trip, will be required.

WEEK 8 THE AUTOMOBILE IN THE U.S.

Themes:

American acceptance of the auto; Fordism; GM's internal combustion empire; petrochemicals

Readings:

John M. Staudenmaier and Claudia Stein, "Notes on the Automobile," unpublished manuscript.

James J. Flink, **The Car Culture** (Cambridge, Mass.: MIT Press, 1975), pp. 1-139.

WEEK 9 CONSUMERISM

Themes:

The Consumerist Ideal; Electricity, Autos, and Advertising Agencies as "Consumer Push" systems; Advertising & Tear Gas as control technologies

Readings:

John M. Staudenmaier, "American Technology and Adult Commitment," **Studies in the Spirituality of Jesuits** 19 (January 1987): entire issue.

Daniel P. Jones, "From Military to Civilian Technology: The Introduction of Tear Gas for Civil Riot Control," **Technology and Culture** 19 (April 1978): 151-168.

A. Michael McMahon, "An American Courtship: Psychologists and Advertising Theory in the Progressive Era," **American Studies** 13 (Spring 1972): 5-18.

PART III: THREE CURRENT PROBLEM AREAS

WEEK 10 COMPUTER AND COMMUNICATIONS TECHNOLOGIES

Themes:

Telephone, Radio, TV, Computer

Readings:

Thomas M. Smith, "Project Whirlwind," **Technology and Culture** 17 (July 1976): 447-464.

Shoshanah Zuboff, "Problems of Symbolic Toil," **Dissent** 29 (Winter 1982): 51-61.

Robert Howard, "High Technology and the Re-enchantment of the Workplace," unpublished manuscript.

Second 4-page thematic essay due

WEEK 11 THE ATOMIC BOMB

Themes:

The Manhattan Project: an 'untypical' US technology; the arms race; nuclear power systems

Film: The Day After Trinity

Readings:

Richard G. Hewlett, "Beginnings of Development in Nuclear Technology," **Technology and Culture** 17 (July 1976): 465-478.

Michael Smith, "The Atom in Postwar Popular Culture," unpublished manuscript.

R.J. Lifton, "The Psychic Effects of the Nuclear Age," **New York Times Sunday Magazine** (September 26, 1982).

Eric J. Lerner, "Major Power Strategies," **IEEE Spectrum** 19 (October 1982): 66-75.

WEEK 12 BREAD AND WATER

Themes:

U.S. Agricultural Style: 19th vs. 20th century styles; the Green Revolution as transfer of technological style from US to the rest of the world

Readings:

John Staudenmaier, "The Green Revolution," unpublished manuscript.

FINAL EXAM

TERM PAPER

Focus: "The 'Image' of a Technology in the Media"
Graduate Students Only [Typed except by arrangement]

Select a technology from 1890 to 1950 and interpret its media image in one of two ways:

A) Article Approach: Select 10 to 15 articles about your technology [**The Readers Guide to Periodical Literature** is a good starting point] and analyze their language, pictures, headlines, etc. to see how that technology was imaged in the various articles.

B) Advertisement Approach: Select 25 to 40 advertisements and analyze their imaging of the technology.

WHAT I LOOK FOR IN AN "A" TERM PAPER

INTRODUCTION [containing the following]

1. A historical frame of reference for your technology in the time period you are focusing on. Base your historical background on solid historical books or articles.
2. Clear explanation of how the technology you are writing about works.
3. An explanation of why you chose the time period(s) you did and why they are of interest to you the researcher. (This means that you have considered several alternative time periods before selecting the one you did.)
4. A discussion of the primary evidence (see below for an explanation of primary evidence) you have chosen to base your paper on. There might be some things you could not find and other things you did not chose to include. Explain why.

PRIMARY EVIDENCE

The heart of your paper should be based on "primary" and not "secondary" evidence. "Primary evidence" and "secondary evidence" differ this way. Primary evidence is material that gives you, the writer of the term paper, direct access to whatever it is you are studying. Secondary evidence is some other author's description of what it is you are writing about. Here are a few examples:

If you are writing about how automobiles were manufactured at Ford Motor Company in 1914:

Primary evidence would be:
a. photographs or files of the actual production process

b. company records about wages paid, number of workmen, etc.
c. memos written at the time by superintendents at Ford

Secondary evidence would be:
a. history books about Ford Motor Company
b. articles about what Ford Motor Company was doing

On the other hand, if you are writing about "the media image" of car manufacturing at Ford in 1914:

Primary Evidence would be:
a. articles about Ford published at that time
b. newspaper cartoons or editorials about Ford published then
c. advertisements by Ford marketing how their cars were made

Secondary Evidence would be:
a. some other author's interpretation of that media image

A WELL WRITTEN PAPER

1) will have a really careful plan for placement of each segment of the paper and each sub-segment within the larger sections; in short, "coherence."
2) will be well written. Each sentence and each paragraph should be well crafted, "pleasing" to the mind's ear, in short, "style."

CONCLUSION

Your conclusion should summarize what you have found in a few paragraphs that help the reader to understand the most important findings you have come up with.

BIBLIOGRAPHY AND SOURCE NOTES

Throughout the paper the reader should know which evidence supports your observations. See me for several acceptable styles of source notes.

APPENDICES

It is very helpful for you to include xeroxed copies of major advertisements or articles that are your primary evidence. Sometimes cartoons or photographs are particularly helpful. Number each item in the appendix so that you can refer to each one by number as you write about it in the paper. (Be sure the date of each item is marked on it!)

SECTION I: TECHNOLOGY IN HISTORY

Part 3: Themes in the History of Technology

THE HISTORY OF FLIGHT

Guy V. Beckwith James R. Hansen
W. David Lewis Stephen L. McFarland
Wesley P. Newton William F. Trimble
Department of History
Auburn University
Auburn, Alabama

INTRODUCTION

The History of Flight (HY 580) is a course intended primarily for upperclass undergraduate students, although graduate students may also enroll in it, and carries five hours of academic credit. The aim of the course is to provide an opportunity to study key epochs in the development of aerospace history more intensively and at a somewhat deeper conceptual level than is possible in the department's previously existing survey course on the History of U.S. Air Power (HY 380), which carries three hours of credit. In History of Flight (HY 580) an effort will be made to strike a proper balance between operational and technological aspects of the history of flight, and to provide coverage of the peacetime as well as military aspects of aerospace developments. Among the various student clienteles served by the course are students enrolled in Auburn's large Air Force ROTC program; students in the university's Aviation Management curriculum; and undergraduates looking toward careers in governmental agencies.

REQUIRED TEXTBOOKS

Roger E. Bilstein, **Flight in America, 1900-1980: From the Wrights to the Astronauts** (Baltimore and London: The Johns Hopkins University Press, 1984).

Robin Higham, **Air Power: A Concise History** (Manhattan, Kansas: Sunflower University Press, 1984).

Alex Roland, ed., **A Spacefaring People: Perspectives on Early Spaceflight** (Washington, D.C.: National Aeronautics and Space Administration, 1985).

COURSE OUTLINE

Week 1:

Developments in aerostation, aviation, and rocketry before 1903, stressing particularly the contributions of Asian and European developers of rocketry; the origins of aerodynamic theory and the progress of scientific and technological developments which facilitated aerostation and aviation; the work of such figures as the Montgolfiers, Charles, Robert, Cayley, Giffard, Lilienthal, Chanute, Langley, Santos-Dumont, Zeppelin, and the Lebaudy Brothers.

[Bilstein, **Flight in America**, pp. 3-9]

Week 2:

The beginnings of powered heavier-than-air flight, stressing particularly the contributions of the Wright brothers, Curtiss, Farman, Bleriot, Cody, Garros, Quimby, de la Roche, and various other significant figures of the pioneering and

barnstorming eras. Social and cultural reactions to aviation and barnstorming will also be analyzed.

[Bilstein, **Flight in America**, pp. 9-26]

Week 3:

The origins and development of military air power from its origins in the French Revolution, the Napoleonic Wars, the Revolutions of 1848, the U.S. Civil War, the Franco-Prussian War, the Spanish-American War, the Italo-Turkish War, the Balkan Wars, and the Mexican Revolution. Some attention will be paid to actual operations, but equal attention will be paid to the first efforts to limit aerial warfare even before it was much utilized.

[Higham, **Air Power**, pp. 1-12]

Week 4:

World War I. Some attention will be devoted to the use of air power in this conflict, but as much attention will be devoted to the evolution of the technology of aerial warfare in military campaigns and in naval warfare and the implications for the future.

[Bilstein, **Flight in America**, pp. 31-37; Higham, **Air Power**, pp. 13-27]

Week 5:

Air power in the interwar period. Some emphasis will be placed upon air power doctrines, especially to the ideas and the influence of the major "Prophets of Air Power"--Douhet, Trenchard, and Mitchell. The technology of military aviation will be linked to this influence, and a brief look will be given to the employment of that technology in the "testing grounds" of China and Spain. Briefly examined will be such related topics as the development of the aircraft carrier, the influence of such organizations as the National Advisory Committee for Aeronautics in the United States, the relationship of aircraft manufacturing to national security, and the impact of the technological revolution of the 1930s upon military aviation. The role of women and other minorities will be examined in barnstorming, speed racing, airlines, and other activities.

[Bilstein, **Flight in America**, pp. 41-48, 59-77, 116-123; Higham, **Air Power**, pp. 42-48]

Week 6:

The rise of civil and commercial aviation, including the origins and development of air mail; the emergence of commercial airlines in the United States, Great Britain, and other countries; the aerial pathfinding of such figures as Lindbergh, Post, and Earhart; the progress of aircraft manufacturing; the improvement of aircraft design, stressing the importance of racing, sports flying, and record-setting, as well as the involvement of such organizations as the Guggenheim Foundation; governmental regulation of aviation; and the social significance of "aviation mindedness" among civilian populations.

[Bilstein, **Flight in America**, pp. 26-31, 37-39, 48-59, 78-116]

Week 7:

World War II. There will be a brief analysis of the impact of air power upon this conflict, especially stressing strategic bombardment, carrier warfare, and the role of the airlines. To be examined in some detail will be the wartime aircraft industry, and the development and use of the first nuclear weapons. The key roles of such individuals as Arnold, Spaatz, Doolittle, LeMay, Harris, Nimitz, and Halsey will be probed, as well as the role of science and such scientists as Fermi and Oppenheimer. There will be some focus on the role of women and blacks in World War

II air power, with the WAAF in the Battle of Britain, the "Night Witches" of Russia, the WASPS of the USAAF, and the Tuskegee flyers as some leading examples.
[Higham, **Air Power**, pp. 61-126]

Week 8:
Military aviation and rocketry in the post-World War II era, as intensified by the Cold War rivalry, including such subjects as the Berlin Airlift, the Korean War, the Cuban Missile Crisis, and the Vietnam War; the emergence of such doctrines as Massive Retaliation, Mutual Assured Destruction, and the "Star Wars" defense concept; the development of specific types of aircraft and missiles; the military implications of the Sputnik Crisis and the Space Race; and the use of aircraft and space satellites for espionage.
[Higham, **Air Power**, pp. 128-156]

Week 9:
Civil and commercial aviation in the post-World War II era, including the explosive growth of airline development with the use of Delta Air Lines as a case example; the transfer of jet technology to civilian use; the revival of ballooning, ultralight aircraft, hang gliders, and aerial record-setting; the development of communications satellites and other business uses of space technology; deregulation and its implications.
[Bilstein, **Flight in America**, pp. 169-178, 195-203, 227-245, 257-267, 290-299]

Week 10:
Space exploration in the post-World War II era, including immediate postwar developments leading up to the International Geophysical Year; the launching of Sputnik and subsequent Soviet space achievements; American efforts to catch up as embodied in the Mercury, Gemini, and Apollo projects, culminating in the Moon landing of 1969; the reassessment of space programs after 1969; the development of Skylab, Space Shuttle, the Apollo-Soyuz mission, and the industrialization and militarization of space; unmanned exploration of Mars, Venus, Jupiter, and space probes to more distant parts of the universe; the individual roles of such persons as Von Braun, Gagarin, Glenn, Tereshkova, Armstrong, and Ride. Other topics will include the future of aerospace; the effect of environmentalism on aviation and space exploration; the possible establishment of manned space stations and space colonies, orbital factories, lunar and Martian bases, and national space forces.
[Bilstein, **Flight in America**, pp. 164-165, 205-218, 267-283, 313-325;
Roland, **A Spacefaring People**, pp. 32-38, 68-73, 81-130, 137-148]

GRADING

Grade will be determined by the performance of the student on two hourly examinations and a final. Each of the hourlies will count 25 percent of the student's grade, and the final will count 50 percent. Although not comprehensive, the final will include about one-half of the material covered in the course. In addition, undergraduate students will be required to write a paper and graduate students will be required to submit an annotated bibliography. For undergraduates, the paper will be used to determine the course grade in borderlines cases: for graduates, the grade on the bibliography will adjust the student's course grade up or down one letter grade.

SELECTED BIBLIOGRAPHY OF WORKS DEALING WITH AEROSPACE HISTORY

General Works

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Haydon, F. Stansbury. **Aeronautics in the Union and Confederate Armies** (Baltimore: The Johns Hopkins University press, 1941).

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Rapoport, Anatol. **Strategy and Conscience** (New York: Schocken Books, 1969).
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Green, Constance M., and Milton Lomask. **Vanguard: A History** (Washington, D.C.: Smithsonian Institution Press, 1971).
Hacker, Barton C., and James M. Grimwood. **On the Shoulders of Titans: A History of Project Gemini** (Washington, D.C.: National Aeronautics and Space Administration, 1977).
Hall, R. Cargill. **Lunar Impact: A History of Project Ranger** (Washington, D.C.: National Aeronautics and Space Administration, 1977).
Hallion, Richard P. **The Path to the Space Shuttle: The History of Lifting Reentry Technology** (Washington, D.C.: United States Air Force, 1983).
Hallion, Richard P., and Tom D. Crouch. **Apollo: Ten Years Since Tranquility Base** (Washington, D.C.: Smithsonian Institution Press, 1979).
Killian, James R. **Sputnik, Scientists, and Eisenhower** (Cambridge, Mass.: The MIT Press, 1977).
Koppes, Clayton R. **JPL and the American Space Program: A History of the Jet Propulsion Laboratory** (New Haven, Conn.: Yale University Press, 1982).
Lehman, Milton. **This High Man: A Biography of Robert H. Goddard** (New York: Ferrar Straus and Company, 1963).
Logsdon, John. **The Decision to Go to the Moon** (Cambridge, Mass.: The MIT Press, 1976).
Mailer, Norman. **Of a Fire on the Moon** (Boston: Little, Brown and Co., 1969)
McDougall, Walter A. **...the Heavens and the Earth: A Political History of the Space Age** (New York: Basic Books, 1985).
Michener, James. **Space** (New York: Ballantine Books, 1982).
Oberg, James E. **Red Star in Orbit** (New York: Random House, 1981).
O'Neill, Gerard K. **The High Frontier: Human Colonies in Space** (New York: William Morrow and Co., 1977).
Riabchikov, Evgeny. **Russians in Space** (Garden City, N.Y.: Doubleday, 1971).
Swenson, Lloyd S., et al. **This New Ocean: A History of Project Mercury** (Washington, D.C.: National Aeronautics and Space Administration, 1966).
von Braun, Wernher, and Frederick I. Ordway. **History of Rocketry and Space Travel**, 3rd ed., (New York: Thomas Y. Crowell, 1975).
Winter, Frank H. **Prelude to the Space Age: The Rocket Societies, 1924-1940** (Washington, D.C.: Smithsonian Institution Press, 1983).
Wolfe, Tom. **The Right Stuff** (New York: Farrar, Straus & Giroux, 1979).

HISTORY OF THE SPACE PROGRAM

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COURSE DESCRIPTION

This course covers the history of the development of space travel, with a focus on the U.S. space program, from 1958 to the present. It is concerned primarily with an examination of how space policy is made. Members of the class are expected to develop a variety of opinions about what space policy should be.

COURSE REQUIREMENTS

The reading for this course is not as heavy as it looks; most of the assigned articles are short. But the reading will take thought because it presents a variety of opinions in their original form, rather than the conclusions of historians. Analyzing and drawing conclusions from the reading will be central to the course, so it is essential that you do the reading and come prepared to discuss it in class. Seats will be assigned so that the instructor can more easily take attendance and grade class participation.

No one book provides an overview for this course; you will quickly find yourself lost if you do not attend class. Six absences will be allowed without penalty. Coming late or leaving early will count as one half an absence. Excuses do not have to be given for the six allowed absences, but it is expected that these will cover all scheduled events (including all extracurricular activities) and minor illnesses. Additional absences will be excused only for emergencies, serious illness, or funerals. Students with more than six absences will be penalized 1/3 of a grade for every two additional absences on their final grade for the course.

Grading will be based on a research paper, the final exam, and five quizzes. All quizzes and the entire final exam will consist of essay questions--the point of this class is to analyze the development of the space program and evaluate contradictory opinions, not to learn facts. Two quizzes will be take-home; three will be in-class and will take up approximately twenty minutes of class time each. Late quizzes will be penalized in the same way as late papers (see below). A missed quiz can be made up, or extra credit can be earned by making a ten minute presentation to the class on some relevant subject on which you have special expertise or by writing a short analysis of a relevant outside lecture or extra reading. These extra credit assignments must be arranged with the instructor.

Suggested topics for the research paper will be handed out, but you may invent your own topic, if you get my approval for the alternate topic at least two weeks before the paper is due. The research paper should be 10 to 15 double-spaced typed pages, properly documented with footnotes or endnotes. Late papers will be downgraded one third of a grade for each class meeting late (e.g., a paper one week late could be downgraded from a B+ to a C+). Extensions will be given only for emergencies.

Papers must be analytical; that is, they must ask a question or state a thesis and then develop the argument using specific evidence to prove a point. Some of the factors that will determine paper grades are: understanding of the material, originality, organization of the argument, use of evidence, thoroughness of research, and writing style (organization, grammar, spelling, etc.). It is your responsibility to understand the definition of plagiarism. Help with paper writing can be obtained from the English Writing Lab in Daniels Hall or from the book **History: A Beginning Student's Manual**, available from the bookstore. I am always glad to discuss ideas and outlines, and will read and comment on rough drafts if they are handed in at least a week before the paper is due. A bibliography that may be helpful in getting started can be found in **A Spacefaring People**, pp. 61-67. Many valuable sources can be found in the government documents section of the library. You need to go there to find out about those documents; they are not listed in the card catalog on on LUIS.

GRADING

Research Paper	30%
Two Take Home Quizzes	10% each
Three In Class Quizzes	5% each
Final Exam	30%
Class Participation	5%

TEXTS

Two books are available in the bookstore:

Frank W. Anderson, Jr., **Orders of Magnitude: A History of NACA and NASA, 1915-1980** (Washington, D.C.: NASA SP-4403, 1981).
Alex Roland, ed., **A Spacefaring People: Perspectives on Early Spaceflight** (Washington, D.C.: NASA SP-4405, 1985).

All other readings are in a xerox packet available for purchase.

COURSE SCHEDULE
[This semester-length course meets tri-weekly, Editor]

Readings are listed under each lecture or discussion topic. All readings that are not in one of the textbooks are contained in the xerox packet.

1. Introduction

2. The Early Theorists
   Nicholas Daniloff, **The Kremlin and the Cosmos** (New York: Knopf, 1972), ch. 1, pp. 11-33.

3. Rockets for Hitler
   Frederick I. Ordway III and Mitchell R. Sharpe, **The Rocket Team** (New York: Thomas Y. Crowell, 1979), pp. 12-29.

4. Early Research in the U.S.
   Anderson, **Orders of Magnitude**, ch. 1, pp. 1-19.

5. The V-2 Comes to America
   Excerpts from the interrogation of Wernher von Braun, in **Documents in NASA History: An Anthology** (Washington, D.C.: NASA HHR-43, 1975), doc. I-1, pp. 13-19.

6. The Uses of Rockets
   Walter A. McDougall, **...the Heavens and the Earth: A Political History of the Space Age** (New York: Basic Books, 1985), pp. 97-131.

7. Sputnik
   "The Impact of Sputnik on the Standing of the US Versus the USSR," and "Post-Sputnik Attitudes Towards NATO and Western Defense," in **Documents in NASA History**, docs. I-5 and I-6, pp. 40-45.

8. Birth of the Space Age
   "John Noble Wilford, "A Spacefaring People," and commentary, in Roland, **A Spacefaring People**, pp. 68-77.
   [Quiz 1]

9. U.S. Reaction
   "Introduction to Outer Space," in **Documents in NASA History**, doc. II-1, pp. 50-59.

10. The Founding of NASA
    "National Aeronautics and Space Act of 1958," in **Documents in NASA History**, doc. II-2, pp. 60-80.

11. Launching a U.S. Satellite
    Constance McLaughlin Green and Milton Lomask, **Vanguard: A History** (Washington, D.C.: NASA SP-4202, 1970), ch. 11, pp. 185-212.

12. Goals of the Space Program
    Harvey Brooks, "Motivations for the Space Program: Past and Future," in Allan A. Needell, ed., **The First 25 Years in Space** (Washington, D.C.: Smithsonian Institution Press, 1983), pp. 6-26.

13. Early NASA Plans
    "Some Thoughts on the next Decade of Space Exploration" (Dec. 1958) and excerpts from "The Long Range Plan of the National Aeronautics and Space Administration" (Dec. 1959) in **Documents in NASA History**, docs. II-4 and II-5, pp. 107-128.

14. Balancing the Options
    Anderson, **Orders of Magnitude**, ch. 2, pp. 20-46.
    John Logsdon, "Opportunities for Policy Historians: The Evolution of the U.S. Civilian Space Program," in Roland, **Spacefaring People**, pp. 81-107.

15. Why Put People in Space?
    Max Born, "Blessings and Evils of Space Travel," **The Bulletin of the Atomic Scientists** 22 (Oct. 1966): 12-14.

16. Man in Space Soonest
    "Invitation to Apply for Position of Research Astronaut-Candidate" and "Project Mercury Astronaut Training Program" in **Documents in NASA History**, docs. VI-1 and VI-2, pp. 341-363.

17. Project Mercury
Lloyd Swenson, Jr., James M. Grimwood, and Charles C. Alexander, **This New Ocean: A History of Project Mercury** (Washington, D.C.: NASA SP-4201, 1966), ch. 10, pp. 303-338.

18. The Decision to Go to the Moon
John M. Logsdon, **The Decision to Go to the Moon** (Chicago: University of Chicago Press, 1976, first publ. 1970), ch. 4, pp. 93-130.
[Second Quiz Due]

19. The Management Challenge
Arnold S. Levine, "Management of Large-Scale Technology," in Roland, **Spacefaring People**, pp. 39-53.

20. The Lunar Mode Decision
Anderson, **Orders of Magnitude**, ch. 3, pp. 47-70.
Excerpts from interview with Dr. John D. Bird, in **Documents in NASA History**, doc. VI-9, pp. 402-407.

21. Moon Landing
"Summary of Changes" from **Manned Space Flight Report: Actions Taken as a Result of the AS-204 Accident**, in **Documents in NASA History**, doc. VI-3, pp. 364-371.

22. Reaction to Apollo Success
John Walsh, "Aerospace: Unemployed Scientists, Engineers Have No Place to Go," **Science** 170 (Dec. 25, 1970): 1384-1387.
Tables: "NASA Budget 1959-1979" and "Funding for Space Science as A Percentage of Total NASA Budget," Congressional Research Service, **United States Civilian Space Programs, 1958-1978**, pp. 59 and 716.

23. Controversy Over the Future of the Manned Program
W. David Compton and Charles D. Benson, **Living and Working in Space: A History of Skylab** (Washington, D.C.: NASA SP-4208, 1983), ch. 1, pp. 2-21.

24. Science and Apollo
Anderson, **Orders of Magnitude**, ch. 4, pp. 71-84.

25. Opportunities for Space Science
H. H. Hess, "Future Goals of the Space Science Program," and Albert R. Hibbs, "Exploration of the Moon, the Planets, and Interplanetary Space," in **Documents in NASA History**, docs. VII-5 and VII-6, pp. 442-451.

26. Class will meet in the Government Documents area of the library for orientation on finding government documents.
Richard P. Hallion, "The Next Assignment: The State of the Literature on Space," in Roland, **Spacefaring People**, pp. 61-67.

27. Successes of Space Science
J. A. Simpson, "Space Science and Exploration: A Historical Perspective," in Roland, **Spacefaring People**, pp. 3-31.
[Third Quiz]

28. Space Science: Plans for the Future
Paul A. Hanle, "Congress and the Large Space Telescope," **National Air and Space Museum Research Report** (Washington, D.C.: Smithsonian Institution Press, 1984), pp. 89-95.

29. Developing Space Applications
Pamela Mack, "Satellites and Politics: Weather, Communications, and Earth Resources," in Roland, **Spacefaring People**, pp. 32-38.
"Hearing before the Federal Communications Commission on commercial communications satellites" and Otto E. Berg, "High Altitude Portrait of Storm Clouds," in **Documents in NASA History**, docs. VIII-1 and VIII-2, pp. 475-490.

30. Planning a Post-Apollo Program
John Logsdon, "Shall We Build the Space Shuttle?" **Technology Review** 74 (Oct/Nov 1971): 49-57.
Anderson, **Orders of Magnitude**, ch. 5, pp. 85-99.

31. Difficulties for the Shuttle Program
Claude E. Barfield, "Technology Report: Intense Debate, Cost Cutting Precede White House Decision to Back Shuttle," **National Journal** 4 (Aug. 12, 1972): 1289-1299.

32. Was the Shuttle a Success?
Alex Roland, "The Shuttle: Triumph or Turkey," **Discover** 6 (Nov. 1985): 29-49.
John F. Guilmaratin, Jr., and John W. Mauer, letter to the editor, **Discover** 6 Dec. 1985): 88.

33. The Shuttle Accident
William Lasser and Stephen H. Wainscott, "Teacher Didn't Belong in Space," Charlotte, N.C., **Observer** (Feb. 9, 1986): 4D-5D.
Jana Harris, "The Weather on a Tuesday (for Christa McAuliffe)," unpublished poem, 2 pages.
[Fourth Quiz Due]

34. International Space Programs: Europe
Walter A. McDougall, "Space-Age Europe, 1957-1980," in Roland, **Spacefaring People**, pp. 108-117.

35. The Third World
"Relevance of Space Activities to Economic and Social Development," in United Nations (Ralph Chipman, ed.), **The World in Space: A Survey of Space Activities and Issues** (Englewood Cliffs, N.J.: Prentice-Hall, 1982), ch. 8, pp. 489-516.

36. Asia and the Soviet Union
Edward C. Ezell, "Space Activities in the Soviet Union, Japan, and the People's Republic of China," and commentary, in Roland, **Spacefaring People**, pp. 118-134.

37. International Cooperation
Arnold W. Frutkin, "Patterns of International Cooperation in Space," in **Documents in NASA History**, doc. X-4, pp. 606-622.

38. The Military in Space: Reconnaissance
Anthony Kenden, "U.S. Reconnaissance Satellite Programmes," **Spaceflight** 13 (July 1968): 243-262.

39. The Military and the Space Shuttle
Jack Manno, **Arming the Heavens: The Hidden Military Agenda for Space, 1945-1965** (New York: Dodd, Mead & Co., 1984), ch. 15, pp. 150-156.
[Paper Due]

40. The Strategic Defense Initiative: History
Union of Concerned Scientists (John Tirman, ed.) **The Fallacy of Star Wars** (New York: Vintage Books, 1984), ch. 1, pp. 3-35 (with notes on pp. 261-263).

41. The Strategic Defense Initiative: Debate
John C. Toomay, "The Case for Ballistic Missile Defense," and George Rathjens and Jack Ruina, "BMD and Strategic Instability," in Franklin A. Long, **et al.**, eds., **Weapons in Space** (New York: W.W. Norton, 1986), pp. 219-255.

42. Historical Background to a Space Station
John M. Logsdon, "Space Station: A Historical Perspective," in Mireille Gerard and Pamela W. Edwards, eds., **Space Station: Policy Planning and Utilization** (New York: American Institute of Aeronautics and Astronautics, 1983), pp. 14-22.
[Fifth Quiz]

43. A Space Station Approved
James M. Beggs, "Space Station: The Next Logical Step," **Aerospace America** 22 (Sept. 1984): 47-55.
Craig Covault, "Unique Products, New Technology Spawn Space Business," **Aviation Week and Space Technology** 120 (July 25, 1984): 40-51.

44. Future Goals
"The Rationale for Space Exploration," section in Roland, **Spacefaring People**, pp. 137-150.

INVENTION AND INNOVATION

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INTRODUCTION

A key characteristic of modern society is the rapid and continuing growth of science and technology. Most of us not only regard advances in science and technology as essential to the general progress of civilization but we have come to expect that scientific and technological breakthroughs will improve the quality of our individual lives. What are some of the sources of scientific and technological innovation? Does new science and technology simply spring from the minds of individual geniuses? How do social and economic factors influence the development of science and technology? Can we detect patterns and techniques in the styles of scientists and inventors and apply these observations to improving our own creative work? Can we manage and plan creativity, or do the muses speak only when they choose to do so? These are some of the questions we raise in this course.

COURSE GOALS AND TEACHING TECHNIQUES

In teaching this course, our primary goal is to introduce students to concepts and perspectives that will help them make sense of the creative process in science and technology. One of our goals is to demonstrate that creativity is not totally mysterious. By studying cases like Einstein and Edison, examples like the development of the atom bomb and psychological experiments on scientific reasoning, students can begin to understand how innovations and inventions occur.

Another goal of the course is to demonstrate how historians and psychologists investigate a complex phenomenon such as creativity. To accomplish these goals, we will use a variety of teaching techniques, including the following:

1. A Seminar Format: Discussion and interaction will be the primary modes of learning.

2. Use of Scholarly Articles: Rather than having you study a textbook, we have selected readings from the historical and psychological literature on creativity. For example, to investigate Einstein's creative process, you will read an article written by Gerald Holton, one of the leading Einstein scholars. [For other examples see the "Course Readings" list]

3. Notebooks: You will use notebooks to keep track of important features of the reading assignments and to prepare for discussion in class. You will be given specific questions (see attached "Questions on the Assigned Readings") to answer in your notebooks, but you will also be expected to jot down your own ideas and observations. Creative geniuses such as Thomas Edison and Michael Faraday used notebooks to record and develop their ideas; we encourage you to use notebooks in a similar way, as a heuristic to think through and refine you own ideas.

4. Group Projects and Presentations: We devote the first half of the course to analysis and discussion. In the last part of the course, we will build upon this common foundation by having you work together in groups to explore a topic on invention and discovery. We will supply a list of sources from which each group can choose (see "Suggested Topics and Books for Group Research Projects," below) and will regularly meet with each group, helping it shape its research into a group presentation in which you will share your discoveries with the rest of the class. These projects give you the opportunity to learn about social science and historical research by doing it.

5. Debate and Discussion: You will get to watch both of us present our different perspectives (history/psychology) in class. We will argue (in a civil manner) in front of the class and invite you to enter the debate.

In summary, our goal is to teach about innovation by using a variety of teaching methods. These methods will also help you to develop skills, such as analyzing and presenting scholarly research, that will be useful in whatever work you do (see "Specific Benefits" below).

SPECIFIC BENEFITS

One of the key benefits you should obtain from this course is the enhancement of your analytical skills. By this we mean that we will encourage you to identify the structure or argument of the articles, to evaluate how well the authors use evidence to support their arguments, and to comment upon the authors' personal opinions or perspectives. To accomplish this, we integrate reading assignments with class discussions. The readings progress from fairly simple, short pieces to scholarly essays with increasingly complex theoretical frameworks. For example, we began the course with a newspaper article, move on to a story by Jeremy Bernstein which is intended for a general audience, then move to an in-depth scholarly analysis of the roots of Einstein's creativity by Gerald Holton, and, finally, attack a complex philosophical argument by Thomas Kuhn. The material from the earlier, simpler articles is critically important for understanding the later, more complex ones, so students will have to keep up on reading. In class, we will discuss the articles with you, using your notebook responses as a starting point. We will show you how to take an article apart, revealing the main arguments, the evidence used to support them, and what these say about the authors' biases.

A second benefit of the course is that you should learn to see social science scholarship and research not as a static, impersonal entity, but as a dynamic enterprise practiced by real people. Throughout the course, we will try to teach you more than just the "facts" of creativity; we will try to show you how scholars from different disciplines think about a topic like creativity. We will do this by regularly discussing, even debating, ideas before the class and by trying to explain major scholarly perspectives on the sources of innovation, relating them to the readings. We will also seek to give you the opportunity to obtain "hands on" experience in social science research. For instance, in previous courses, some students ran psychology experiments exploring how individuals solve mathematical problems while other groups conducted a bibliographic search in the history of technology and business and then worked together to provide a synthetic review of the literature.

While much of the course is devoted to showing you how social science knowledge is created, another important benefit of the course is to provide you with a set of

ideas or concepts which you can use to make sense of creativity during the rest of your careers. Rather than assuming that creative behavior is random and even irrational, we hope you will come to understand that there are ways to understand where new ideas come from and that, in fact, there are ways to guide and manage creativity.

COURSE STRUCTURE

During the first five weeks of the course, we will review a number of different concepts about innovation and discovery, with the instructors making brief presentations before discussion of the assigned readings.

During weeks six through eight, the class will break up into research groups in order to pursue several topics. Among the possible group topics are:

*scientific and technological revolutions
*method and style of invention
*the social context of innovation in computers or electricity
*discovery and implementation: the case of the atomic bomb
*discovery as process
*psychology of science
*institutionalizing innovation
*biography
*physics as community and profession

In addition to these topics, you are welcome to pursue an alternative idea, provided you clear it with us by Week 5. All groups will meet regularly with the instructors while pursuing their topics.

Finally, in the last two weeks of the term, the class will again meet as a whole to hear and discuss the presentations of each group.

COURSE REQUIREMENTS

This course's requirements include reading assignments, class discussions, group presentations, and a final paper. To help you keep up with the reading assignments, you will be required to maintain an intellectual journal. The purpose of this journal is to provide you with an opportunity to write down your reactions to every reading. To help you evaluate the readings, we will sometimes assign questions to which you should respond in your journal. You should also plan on making an entry both <u>before</u> and <u>after</u> each class meeting. Your journal may be collected and checked <u>at any time</u> in the course, and you may be called on to read your entries in class.

To get maximum benefit from the course, you are expected to attend all of the class meetings and to participate in the discussions; attendance will be taken. Together, your journal and class participation will count for one-half of your final grade. The other half of your grade will be based on your group project and final paper. During the middle weeks of the term, you or your group will meet to report on the progress of your project, and during the last two weeks you will be scheduled to given an oral presentation before the class on your project. Following the oral report you will be asked to write a final paper which summarizes and documents what you have learned about your special topic. This final paper is due on the first day of exam week, following the end of the regular term.

READINGS

For the first four weeks of the course we will use a xeroxed volume of readings available in the bookstore and on reserve in the library. For the group projects, a variety of books will be selected by the instructors and ordered. While you are working on your special project, you will be encouraged to buy one or two of these books so that you will be able to read and study them at length.

COURSE SCHEDULE

[This quarter-length course meets tri-weekly, Editor]

PART I. ISSUES IN INNOVATION AND INVENTION

A. The Intellectual Process of Creativity

1. Introduction to the Course, Readings, and Requirements

2. The Copernican Revolution
   Jeremy Bernstein, "Kepler: Harmony of the World," in **Experiencing Science** (New York: E.P. Dutton, 1978), pp. 3-37.

3. The Heroic, or Genius, Model of Creativity
   William J. Broad, "Does Genius or Technology Rule Science?" **New York Times** (August 7, 1984): 13.
   T. R. Reid, **The Chip: How Two Americans Invented the Microchip and Launched a Revolution** (New York: Simon & Schuster, 1984), pp. 54-67.

4. Technological Innovation as Rational Process
   Thomas P. Hughes, "Edison's Method," in W. B. Pickett, ed., **Technology at the Turning Point** (San Francisco: San Francisco Press, 1977), pp. 5-22.
   Donald A. Schon, **Technology and Change** (New York: Dell, 1967), pp. 1-41.

5. Impact of Ideas on Scientific Discovery
   Gerald Holton, "Influences on Einstein's Early Work," in **Thematic Origins of Scientific Thought: Kepler to Einstein** (Cambridge, Mass.: Harvard University Press, 1973), pp. 197-217.

6. The Myth of the Heroic Scientist
   Gwyn Macfarlane, **Alexander Fleming: The Man and the Myth** (Cambridge: Harvard University Press, 1984), pp. 261-274.

7. Kuhn's Model of Scientific Change
   A. F. Chalmers, **What Is This Thing Called Science?** (St. Lucia: University of Queensland Press, 1978), pp. 85-97.

B. The Psychology of Creativity

8. Creativity as Cognitive Process
   Ryan D. Tweney, "Faraday's Discovery of Induction: A Cognitive Approach," in D. Gooding and F. James, eds., **Faraday Rediscovered: Essays on the Life and Work of Michael Faraday** (New York: Stockton Press, 1985).

9. Experimental Studies of Scientific Reasoning
   Michael E. Gorman, "How the Possibility of Error Affects Falsification on a Task that Models Scientific Problem Solving," **British Journal of Psychology** 77 (Feb. 1986): 85-96.

C. Innovation and Discovery as Social Activities

10. Scientific Controversies
    W. Bernard Carlson, "Elihu Thomson: Man of Many Facets," **IEEE Spectrum** 20 (Oct. 1983): 72-75.
    W. Bernard Carlson, "An Established Man of Science: The Etheric Force Controversy," in Carlson, **Invention, Science, and Business: The Professional Career of Elihu Thomson, 1870-1900**, Ph.D. dissertation, University of Pennsylvania, 1984, pp. 106-122.

11. The Business Context of Innovation
    W. Bernard Carlson, "The Business Context of Innovation: Elihu Thomson and the Rise of the Thomson-Houston Electric Company, 1883-1892," 1983 manuscript, 26 pp.

12. Planning Session for Group Projects

13. Institutionalizing Innovation
    George Wise, "A New Role for Professional Scientists in Industry: Industrial Research at General Electric, 1900-1916," **Technology and Culture** 21 (July 1980): 408-429.

14. The Governmental Context of Innovation: The Atomic Bomb
    James W. Davidson and Mark H. Lytle, "The Decision to Drop the Bomb," in **After the Fact: The Art of Historical Detection** (New York: A. A. Knopf, 1982), pp. 320-355.

D. Summary

15. Discussion of Issues in Innovation and Invention

PART II. GROUP RESEARCH PROJECTS

16-25. You will work with the other members of your group for about three weeks [10 classes] doing research into your topic and preparing a presentation for the whole class that will describe your findings. We will meet with each group at least once a week for an hour to check on your progress and answer questions.

26-30. Set aside for group presentations. Each group will have a full hour to discuss its work. However, leave fifteen minutes of this time for questions and comments. We will put each group through a "dress rehearsal" before you face the class. Each of you will also be expected to complete a 5-10 page paper detailing his or her contribution to the group project and commenting on the group's overall conclusions. What did you learn about the innovation process?

SUGGESTED TOPICS AND BRIEF BIBLIOGRAPHY FOR GROUP RESEARCH PROJECTS

I. Scientific and Technological Revolutions

Butterfield, Herbert. **The Origins of Modern Science** (New York: The Free Press, 1957).

Constant, Edward. **The Turbojet Revolution** (Baltimore: Johns Hopkins University Press, 1981). [an application of Kuhn's paradigmatic model to technological change]

Eisley, Loren. **Darwin's Century** (Garden City, N.Y.: Doubleday, 1961).

Holton, Gerald. **Thematic Origins of Scientific Thought** (Cambridge, Mass.: Harvard University Press, 1973). [on Einstein]

Judson, Horace. **The Eighth Day of Creation** (New York: Simon and Schuster, 1979). [on genetics and recent biology]

Keller, E. Fox. **A Feeling for the Organism** (New York: W. H. Freeman, 1983). [on genetics]

Koestler, Arthur. **The Sleepwalker** (New York: Grossett and Dunlap, 1963). [on Kepler]

Kuhn, Thomas. **The Structure of Scientific Revolutions**, 2nd ed., (Chicago: Univ. of Chicago Press, 1970).

MacDougall, Walter A. **...the Heavens and the Earth** (New York: Basic Books, 1985).

Schneer, C.J. **The Search for Order** (New York: Harper and Row, 1960).

Wallace, A.F.C. **The Social Context of Innovation** (Princeton, N.J.: Princeton University Press, 1981). [on the relationship between the scientific and industrial revolutions]

Webster, Charles. **The Great Instauration** (London: Gerald Duckworth & Co., 1975). [on the scientific revolution of 1600s]

II. Discovery as Process

Bliss, Michael. **The Discovery of Insulin** (Chicago: University of Chicago Press, 1981).

Brannigan, Augustine. **The Social Basis of Scientific Discoveries** (Cambridge: Cambridge University Press, 1981).

Goodfield, June. **An Imagined World** (New York: Penguin Books, 1982).

Watson, J. D. **The Double Helix** (New York: New American Library, 1969).

Woolgar, Stephen, and Bruno Latour. **Laboratory Life** (Princeton, N.J.: Princeton University Press, 1986).

III. Psychology of Science

Gruber, H. **Darwin on Man** (Chicago: University of Chicago Press, 1981).

Mahoney, M.J. **Scientist as Subject** (Cambridge, Mass.: Ballinger, 1976).

Maslow, A. **The Psychology of Science: A Reconnaissance** (New York: Harper and Row, 1966).

Miller, Arthur I. **Imagery in Scientific Thought** (Boston: Birkhauser, 1984).

Perkins, D.N. **The Mind's Best Work** (Cambridge, Mass.: Harvard University Press, 1981).

Rudwick, M.J.S. **The Great Devonian Controversy** (Chicago: University of Chicago Press, 1985).

Tweney, R.D., M.E. Doherty, and C.R. Mynatt. **On Scientific Thinking** (New York: Columbia University Press, 1981).

IV. Social Context of Innovation, I: Computers

Hanson, Dirk. **The New Alchemists** (New York: Avon, 1981).

Hodges, Andrew. **Alan Turing** (New York: Simon and Schuster, 1983).

Hyman, Anthony. **Charles Babbage** (Princeton, N.J.: Princeton University Press, 1982).
Kidder, Tracy. **The Soul of a New Machine** (Boston: Little, Brown and Co., 1981).
Moritz, Michael. **The Little Kingdom** [on Apple Computers] (New York: William Morrow, 1984).
Reid, T.R. **The Chip** (New York: Simon and Schuster, 1984).
Rose, F. **Into the Heart of the Mind** (New York: Harper and Row, 1984).
Turkle, Sherry. **The Second Self: Computers and the Human Spirit** (New York: Simon and Schuster, 1984).

IV. Social Context of Innovation, II: Electricity and Inventors

Cheney, Margaret. **Tesla: Man Out of Time** (Englewood Cliffs, N.J.: Prentice-Hall, 1981).
Conot, Robert. **A Streak of Luck** (New York: Seaview, 1979). [on Edison]
Hughes, Thomas. **Networks of Power** (Baltimore: Johns Hopkins University Press, 1983).
Josephson, Matthew. **Edison** (New York: McGraw-Hill, 1959).

V. Institutionalizing Innovation

Bernstein, Jeremy. **Three Degrees Above Zero** (New York: Charles Scribners, 1984). [on recent research at Bell Labs]
Jenkins, Reese V. **Images and Enterprise** (Baltimore: Johns Hopkins University Press, 1975). [on innovation in the photographic industry]
Leslie, Stuart W. **Boss Kettering** (New York: Columbia University Press, 1983). [on early history of the GM research lab]
Noble, David. **American by Design** (New York: A.A. Knopf, 1977). [on the rise of corporate engineering and research]
Noble, David. **Forces of Production** (New York: A.A. Knopf, 1984). [on the development of automated machine tools]

VI. Discovery and Implementation: The Case of the Atomic Bomb

Broad, W.J. **Star Warriors** (New York: Simon and Schuster, 1985).
Kaplan, F. **The Wizards of Armageddon** (New York: Simon and Schuster, 1983).
McPhee, J. **The Curve of Binding Energy** (New York: Farrar, Straus, and Giroux, 1973).
Sherwin, Martin. **A World Destroyed** (New York: Vintage, 1975).
Wyden, P. **Day One: Before Hiroshima and After** (New York: Simon and Schuster, 1984).

VII. Physics as Community and Profession

Boslough, J. **Stephen Hawkings Universe** (New York: William Morrow and Co., 1985).
Kevles, Daniel J. **The Physicists** (New York: A.A. Knopf, 1978).
McCormmach, R. **Night Thoughts of a Classical Physicist** (Cambridge, Mass.: Harvard University Press, 1982).

VIII. BIOGRAPHY

Banville, J. **Kepler: A Biography** (Boston: David R. Godine Publisher, 1984).
Iaccoca, Lee. **Iaccoca: An Autobiography** (New York: Bantam, 1984).
MacFarlane, G. **Alexander Fleming** (Cambridge, Mass.: Harvard University Press, 1984).
Manuel, F. **A Portrait of Isaac Newton** (Cambridge, Mass.: Harvard University Press, 1968).
Simpson, G. **The Book of Darwin** (New York: Washington Square Press, 1982).
Sulloway, F.J. **Freud: Biologist of the Mind** (New York: Basic Books, 1983).

TECHNOLOGY, SOCIETY, & HUMAN BEINGS

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COURSE GOALS

All of you have come here to work at becoming an engineer. That is your one common denominator as you begin this course. You are not sure that you will succeed. You are not clear--certainly not as clear as you will be four years from now--about what it will mean to you to be an engineer. It is likely that technological things catch your interest or you wouldn't be here, and it is also likely that things mathematical do not terrorize you or, again, you would not be here.

In the next two years, especially, a great deal of your energy will go into basic prerequisites for the field you are majoring in--science, math, and other introductory courses. It will be a while before you sink your teeth into the specifics of your major field in great depth.

Why this course, then, here as you begin? The College of Engineering intends this course to help you in several ways:

1. The course gives you an overview of what it means to be an engineer.
   You will see in the syllabus that most of the weekly readings are case studies--taken from American engineers--of engineering achievements, problems, and failures. The idea is that you best understand what engineering will be like for you when you pay attention to what it has been like for other engineers in this country's development.

2. The course also aims at helping you achieve "technological literacy."
   A person can be "illiterate" about technology in two different ways. S/he can be illiterate because s/he has no ability to understand technical design or because s/he is naive and thoughtless about the societal factors that always influence the design-process. In each case study we treat, I will be asking you to think through and interpret the tension between design-constraints and societal pressures as they bear on the engineers in question.

COURSE CONSTRAINTS AND COURSE STRUCTURE

The most serious constraint in this course is the large number of students in a single class. In a course that demands interpretative thinking (i.e., "technological literacy") this is a serious problem.

To get around the difficulty somewhat we will use alphabetical seating. There is no way that I will be able to call on you for discussion, by name, without having some ease in knowing whom I am talking with.

This is only a 2 hour credit course, and that also limits the work load for you. The result of these constraints is the following course design.

One: Readings:

Each week there will be an assigned reading (usually 20 to 30 pages). You may want to read it before the Tuesday class, but I expect you to have it read by Thursday's quiz time.

Two: Tuesday Class

On Tuesdays I will set the stage for the reading, giving some of the background for it, situating the case study in its context, raising some questions for Thursday's discussion. The material from Tuesday's lectures will be matter for the two examinations, so I expect you to know it.

Three: Thursday Class

On Thursday we will begin class with a three question quiz. The questions will be brief and quite simple. They test whether you have done the reading with some attention. Cumulatively the 13 quizzes of the semester are 30% of your grade. There are scored as follows:

none wrong	= 100%	two wrong	= 80%
one wrong	= 90%	three wrong	= 70%

After the quiz we will discuss the reading and the issues raised in the reading. The session will be a combination of some input from me and a lot of question-answer discussion. Questions or observations from you are an important part of the process . . . so are questions from me to you.

You will note below that class participation counts for 10% of your grade. If you distinguish yourself, over the semester, by your participation in the discussions the 10% will be used to improve your overall grade. However, since we have so many people in the course, it would not be fair to penalize people for lack of participation. So even if you remain silent as a stone all through the term the 10% will simply be taken as the average of the other 90% of your grade.

GRADING

Weekly Quizzes	30% of final grade
Two Long Quizzes	15% each
Final [cumulative]	30%
Class Participation	10%

(In the midterm and the final I will test you on the readings and on the material covered in class.)

I am an old-fashioned teacher in at least one way. I still use the old 7-point grade system. It does not make any difference for you, however, since every number grade eventually gets worked into a single letter grade (A,B,C,D,F) and the purpose of the number grades is simply to indicate whether an individual assignment rates a high, medium, or low A (or B, or C, etc.). However, it is important for you to know what the number grades mean each week, so I will mark the letter grade along with the number grade each time. The 7-point scale looks like this:

A = 100-93 B = 92-85 C = 84-77 D = 76-70 F = 69 and below

COURSE OUTLINE AND ASSIGNMENTS

Week 1: Introduction
Theme: Introduction to the Course
Reading: None

Week 2: Road Building
Theme: Civil Engineering, some political and social problems.
Reading: Robert F. Hunter, "Turnpike Construction in Antebellum Virginia," **Technology and Culture** 4 (Spring 1963): 177-200.

Week 3: John Jervis
Theme: Engineering education in early America/Civil engineering.
Reading: Elting Morison, "The Works of John B. Jervis," in his **From Know-How to Nowhere** (New York: Basic Books, 1974), pp. 40-71.

Week 4: Princeton and Peacemaker
Theme: Technological failures, government funding of R&D, materials testing, inventors, developers, innovators, politics, and engineering.
Reading: Lee M. Pearson, "The Princeton and the Peacemaker," **Technology and Culture** 7 (Spring 1966): 163-183.

Week 5: Standardization
Theme: American ideal of standardization, mechanical engineering. American style of labor-management relations, contrast American and British styles of mechanical engineering.
Reading: Bruce Sinclair, "The Direction of Technology," **Technology and Culture** 10 (Jan. 1969): 20-34.
FIRST LONG QUIZ [10 questions on weeks 1-5]

Week 6: Engineering Education
Theme: The birth of a major engineering school, conflicting styles of engineering education, political influences on engineering education.
Reading: James Brittain and Robert McMath, "Georgia Tech and the New South Creed," **Technology and Culture** 18 (April 1977): 175-201.

Week 7: Scientific Management
Theme: Taylorism and Scientific Management. Are engineers employees or professionals? "Technocracy"
Reading: Edwin Layton, "Measuring the Unmeasurable," in his **Revolt of the Engineers** (Cleveland: Case Western Reserve University Press, 1971; reprinted Baltimore: Johns Hopkins University Press, 1986), pp. 134-153.

Week 8: Kettering at GM
Theme: R&D tensions in a large corporation (personal conflicts shifting research priorities, power struggles, and the failure of a "good design").
Reading: Stuart Leslie, "Kettering and the Copper-cooled Engine," **Technology and Culture** 20 (Oct. 1979): 752-776.

Week 9: Science and Engineering
Theme: Civil engineering style vs. Electrical & Chemical. When does scientific basic research methodology help and when does it get in the way of good engineering?

Reading: Bruce Seely, "Scientific Mystique: Highway Research at the Bureau of Public Roads, 1918-1940," **Technology and Culture** 25 (Oct. 1984): 798-831.

Week 10: "The Faustian Bargain: Selling Your Soul"

Theme: Nazi engineers: why did they work with Hitler? The myth of Faust.

Reading: Thomas P. Hughes, "National Socialist Ideology and German Engineers," pp. 165-181, in Henry Friedlander and Sybil Milton, eds., **The Holocaust: Ideology, Bureaucracy, and Genocide** (Millwood, N.Y.: Kraus International Publications, 1980).

SECOND LONG QUIZ [10 questions on weeks 6-10]

Week 11: Technology Transfer, I

Theme: Technology Transfer: ideologies in conflict (USA vs. USSR), electrical engineering.

Reading: Harold Dorn, "Hugh Lincoln Cooper and the First Detente," **Technology and Culture** 20 (April 1979): 322-347.

Week 12: Engineers & Machinists

Theme: "Sensual" skilled workers vs. "Non-sensual" engineers.

Reading: Robert Shrank, "Machinist" and "Management" in **Ten Thousand Working Days** (Cambridge, Mass.: MIT Press, 1982), pp. 69-84 and 133-145.

Week 13: Engineering Ethics

Theme: Engineering ethics: "whistle blowing" and other moral questions facing engineers in the workplace.

Reading: Rosemary Chalk, "The Miners' Canary," **Bulletin of the Atomic Scientists** 37 (Feb. 1982): 16-22.
P. G. Leventman, **Professionals Out of Work** (New York: Basic Books), pp. 177-184.

Week 14: Western Engineering Style

Theme: How did Western engineering style happen? Impact of Christian theology.

Reading: Lynn White, Jr., "The Historical Roots of our Ecologic Crisis," in his **Dynamo and Virgin Reconsidered** (Cambridge, Mass.: MIT Press, 1968), pp. 75-94.

Week 15: Exam Week

APPENDIX I
SAMPLE EXAM: SECOND LONG EXAM

Directions:

1. Choose one of the three themes listed below.
2. Then identify one course reading (weeks 6-10) that fits at least some major part of the theme.
3. Explain precisely how your example fits the theme and how it does not (e.g., if your case study does not talk about all aspects of the theme or if you think the case study shows something that contradicts the theme).
4. Only one scratched out word permitted.
5. Write on the back of this page.

6. You will be graded on <u>how well you explain</u> the relationship between theme and examples. You will get some credit for the creativity of your choice of case study. To get an A you will have to write a thoughtful essay.

<u>Themes</u>:
1. The Three Constituency Model
2. Types of Technological Knowledge
3. Engineer as Employee vs. Professional

<u>Weekly Readings</u>:
Week 6: Georgia Tech (Brittain & McMath)
Week 7: Scientific Management (Layton)
Week 8: Kettering at GM (Leslie)
Week 9: The Bureau of Public Roads (Seely)
Week 10: The Nazi Engineers (Hughes)

<u>Hint on how to proceed</u>:
1. Outline the entire theme on scratch paper so that you don't forget any major part of it.
2. Put each major part of the theme on a separate line.
3. Choose your example and then write every part of the case study that matches a part of the theme (next to that part of the theme on your scratch paper).
4. Then write out your explanation (still on scratch paper).
5. Then check for grammar (make sure all your sentences make sense, etc.).
6. Finally write your answer out on the back of this sheet.

TECHNOLOGY, SOCIAL CHANGE, AND THE ROLE OF WOMEN

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RATIONALE

This course explores the role of technology as it has evolved through time and its effect on human lives. Studying a relatively new field of academic research, "Technology, Social Change, and the Role of Women" will show how changing technology has altered women's roles. It will bring to our students' consideration a timely approach to some of the important questions of the past and present. It is one of the required courses for the Women's Studies Masters of Arts in Liberal Studies.

COURSE GOALS AND OBJECTIVES

"Technology, Social Change, and the Role of Women" will enable students to learn about the history of technology and the way technological change impinges on human development. Through readings, lectures, and audiovisual materials, this course will teach how women influenced technological change by developing new technologies themselves, or by their choice of work. Current problems growing out of modern technology will be explored against the historical backdrop.

COURSE DESCRIPTION

This course will examine the nature and origins of technology, the influence of its historical development from classical to modern times on women in the United States and Europe, and problems stemming from current technological advance.

REQUIRED GRADED EXERCISES

A midterm and final examination will be given. In addition a short paper consisting of an oral history interview of a person involved in some form of technology is required. You are to inquire how the technology changed during the course of work, how the person reacted to the changes, and what is foreseen in the future. A long paper (15 pages or so) is also required, dealing with a topic to be agreed upon in consultation with the professor. These exercises will receive the following percentages of the grade:

Hour Exam	30%
Final Exam	30%
Long Paper	30%
Oral History Paper (short paper)	10%.

REQUIRED TEXTS

John G. Burke and Marshall C. Eakin, eds., **Technology and Change** (San Francisco: Boyd and Fraser, 1979).

Melvin Kranzberg and Carroll W. Pursell, Jr., eds., **Technology in Western Civilization**, v. 1, (New York: Oxford University Press, 1967).

Martha Moore Trescott, ed., **Dynamos and Virgins Revisited: Women and Technological Change in History** (Metuchen, N.J.: Scarecrow Press, 1979).

COURSE OUTLINE AND ASSIGNMENTS

1. The Nature of Technology: An Overview and Contrasting Views

Kranzberg and Pursell, "The Importance of Technology in Human Affairs," in Kranzberg and Pursell, **Technology in Western Civilization**, ch. 1, pp. 3-11.

Jacques Ellul, "The Technological Order," in Burke and Eakin, **Technology and Change**, pp. 13-19.

Rothschild, "Introduction: Why Machina Ex Dea?," in Joan Rothschild, **Machina Ex Dea** (New York: Pergamon Press, 1983), pp. ix-xxix.

2. The Origins of Technology and Society

Peter Drucker, "The First Technological Revolution and Its Lessons," in Burke and Eakin, **Technology and Change**, pp. 39-46.

Nancy Tanner and Adrienne Zihlman, "Women in Evolution, Part I: Innovation and Selection in Human Origins," **Signs** 1 (Spring 1976): 585-608.

R.J. Forbes, "The Beginnings of Technology and Man," and "Mesopotamian and Egyptian Technology," in Kranzberg and Pursell, **Technology in Western Civilization**, ch. 2-3, pp. 11-47.

George Murdock and Catherine Provost, "Factors in the Division of Labor by Sex," **Ethnography** 12 (April 1983): 203-225.

Autumn Stanley, "Daughters of Isis, Daughters of Demeter: When Women Sowed and Reaped," **Women's Studies International Quarterly** 4, no. 3 (1981): 289-304.

3. Pre-Industrial Technology in Society

Reed Benamou, "Verdigris and the Enterpreneuse," **Technology and Culture** 25 (April 1984): 171-181.

Judith Brown and Jordan Goodman, "Women and Industry in Florence," **Journal of Economic History** 40 (March 1980): 73-80.

Shepherd B. Clough, "Economic and Political Developments, 1600-1750," in Kranzberg and Pursell, **Technology in Western Civilization**, ch. 8, pp. 118-128.

Natalie Zemon Davis, "Women in the Crafts in Sixteenth-Century Lyon," **Feminist Studies** 8 (Spring 1982): 47-80.

G. E. Fussell, "The Agricultural Revolution, 1600-1850," in Kranzberg and Pursell, **Technology in Western Civilization**, ch. 9, pp. 128-142.

Gay Gullickson, "The Sexual Division of Labor in Cottage Industry and Agriculture in the Pays de Caux: Auffay, 1705-1850," **French Historical Studies** 12 (1981): 177-199.

Daryl M. Hafter, "Agents of Technological Change: Women in the Pre- and Post-Industrial Workplace," in Dorothy G. McGuigan, ed., **Women's Lives: New Theory, Research and Policy** (Ann Arbor: University of Michigan, 1980), pp. 159-168.

A. Rupert Hall, "Early Modern Technology, to 1600," and "Cultural, Intellectual, and Social Foundations, 1600-1750," in Kranzberg and Pursell, **Technology in Western Civilization**, ch. 6-7, pp. 79-117.

Lynn White, Jr., "Technology in the Middle Ages," in Kranzberg and Pursell, **Technology in Western Civilization**, ch. 5, pp. 68-79.

4. The Industrial Revolution in Europe and America

Maxine Berg, **The Age of Manufactures, 1700-1820** (New York and Oxford: Oxford University Press, 1986).

Melvin Kranzberg, "Prerequisites for Industrialization," in Kranzberg and Pursell, **Technology in Western Civilization**, ch. 13, pp. 217-230.

Jean Quataert, "The Shaping of Women's Work in Manufacturing: Guilds, Households, and the State in Central Europe, 1648-1870," **American Historical Review** 90 (Dec. 1985): 1122-1148.

Joan Scott, "The Mechanization of Women's Work," **Scientific American** 247 (Sept. 1982): 166-187.

Abbott Payson Usher, "The Textile Industry, 1750-1830," in Kranzberg and Pursell, **Technology in Western Civilization**, ch. 14, pp. 230-245.

Susan Levine, "Ladies and Looms: The Social Impact of Machine Power in the American Carpet Industry," in Trescott, **Dynamos and Virgins**, pp. 67-76.

Judith A. McGaw, "Technological Change and Women's Work: Mechanization in the Berkshire Paper Industry, 1820-1855," in Trescott, **Dynamos and Virgins**, pp. 77-99.

5. Invention as Technical and Social Act

Lynn White, Jr., "The Act of Invention," in Burke and Eakin, **Technology and Change**, pp. 379-392.

Deborah J. Warner, "Women Inventors at the Centennial," in Trescott, **Dynamos and Virgins**, pp. 102-119.

Daryl M. Hafter, "The Programmed Brocade Loom and the Decline of the Drawgirl," in Trescott, **Dynamos and Virgins**, pp. 49-66.

Eugene S. Ferguson, "Nonverbal Thought in Technology," in Burke and Eakin, **Technology and Change**, pp. 400-405.

John Jewkes, David Sawers, and Richard Stillerman, "The Sources of Invention," in Burke and Eakin, **Technology and Change**, pp. 406-416.

Autumn Stanley, "Women Hold Up Two-Thirds of the Sky: Notes for a Revised History of Technology," in Rothschild, **Machina Ex Dea**, pp. 3-22.

6. The Maturation of Industrialization and Women's Work

Ruth Schwartz Cowan, "From Virginia Dare to Virginia Slims: Women and Technology in American Life," **Technology and Culture** 20 (Jan. 1979): 51-63.

Herbert Heaton, "The Spread of the Industrial Revolution," in Kranzberg and Pursell, **Technology in Western Civilization**, ch. 30, pp. 503-514.

Nathan Rosenberg, "The Economic Consequences of Technological Change," in Kranzberg and Pursell, **Technology in Western Civilization**, ch. 31, pp. 515-532.

Susan J. Klienberg, "Technology and Women's Work: The Lives of Working Class Women in Pittsburgh, 1870-1900," in Trescott, **Dynamos and Virgins** , pp. 185-204.

Joan Scott and Louise Tilly, "Women's Work and the Family in Nineteenth-Century Europe," **Comparative Studies in Society and History** 17 (Jan. 1975): 36-64.

7. Technology and the Modern Home

Ruth Schwartz Cowan, "The 'Industrial Revolution' in the Home," in Burke and Eakin, **Technology and Change**, pp. 276-282.

Seigfried Giedion, "Engineering and the Household," in Burke and Eakin, **Technology and Change**, 273-275.

Christine E. Bose, Philip L. Bereano, and Mary Malloy, "Household Technology and the Social Construction of Housework," **Technology and Culture** 25 (Jan. 1984): 53-81.

Joan Vanek, "Household Technology and Social Status: Rising Living Standards and Status and Residence Differences in Housework," **Technology and Culture** 19 (July 1978): 361-375.

William D. Andres and Deborah C. Andrews, "Technology and the Housewife in Nineteenth Century America," **Women's Studies** 2 (July 1974): 309-328.

8. Technology, Leisure, and Gender

Carroll Pursell, Jr., "Toys, Technology and Sex Roles in America, 1920-1940," in Trescott, **Dynamos and Virgins**, pp. 252-268.

John F. Kasson, "Coney Island: A Case Study in Popular Culture and Technological Change," **Journal of Popular Culture** 9 (Spring 1976): 960-975.

M. Kaplan and Philip Bosserman, eds., **Technology, Human Values and Leisure** (Nashville, Tenn.: Abingdon Press, 1971).

9. Technological Utopias

Howard Segal, "The Feminist Technological Utopia: Mary E. Bradley Lane's **Mizora** (1890)," **Alternative Futures** 4 (Spring/Summer 1981): 67-72.

Ruth Schwartz Cowan, "From Virginia Dare to Virginia Slims: Women and Technology in American Life," in Trescott, **Dynamos and Virgins**, pp. 30-44.

John A. Hostetler, "Amish Society," in Burke and Eakin, **Technology and Change**, pp. 168-174.

Patricia Schweikart, "What If ... Science and Technology in Feminist Utopias," in Rothschild, **Machina Ex Dea**, pp. 198-211.

10. High Technology and Women's Employment

Joan Rothschild, "A Feminist Perspective on Technology and the Future," **Women's Studies International Quarterly** 4, no. 3 (1981): 65-74.

Herbert Simon, "What Computers Mean for Man and Society," in Burke and Eakin, **Technology and Change**, pp. 68-76.

Robert H. Guest, "Scientific Management and the Assembly Line," in Burke and Eakin, **Technology and Change**, pp. 98-106.

John H. Broomfield, "High Technology: The Construction of Disaster," **Alternative Futures** 3 (Spring 1980): 31-44.

Rebecca Morales, "Cold Solder on a Hot Stove," in Jan Zimmerman, ed., **The Technological Woman: Interfacing with Tomorrow** (New York: Praeger ,1983), pp. 169-180.

Barbara A. Gutek, "Women's Work in the Office of the Future," in **ibid.**, pp. 159-168.

11. Technology vs. Humanistic Goals

Ralph Nader, "Unsafe at Any Speed," in Burke and Eakin, **Technology and Change**, pp. 290-296.

Barry Commoner, "Are We Really in Control?" in Burke and Eakin, **Technology and Change**, pp. 6-10.

Donald Marlowe, "Public Interest--First Priority in Engineering Design?" in Burke and Eakin, **Technology and Change**, pp. 297-301.

Langdon Winner, **Autonomous Technology: Technics-out-of-control as a Theme in Political Thought** (Cambridge, Mass.: MIT Press, 1977).

Barbara Winters, "Engineered Conception: The New Parenthood," in Zimmerman, **The Technological Woman**, pp. 221-238.

12. Alternative Technologies and How to Get There

Wilson Clark, "Intermediate Technology," in Burke and Eakin, **Technology and Change**, pp. 198-202.

Judy Smith, "Something Old, Something New, Something Borrowed, Something Due: Women and Appropriate Technology" (Missoula, Montana: National Center for Appropriate Technology, 1979), obtained from Women and Technology Network, 315 S. 4th E.; Missoula, MT 59801.

Judy Smith, "Women and Appropriate Technology: A Feminist Assessment," in Zimmerman, **The Technological Woman**, pp. 65-70.

Harvey Brooks, "Technology Assessment in Retrospect," in Burke and Eakin, **Technology and Change**, pp. 465-476.

David Dickson, **Alternative Technology and the Politics of Technical Change** (London: Fontana, 1974), **passim.**

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Cohen, Miriam. "Italian-American Women in New York City, 1900-1950; Work and School," in Milton Canton and Bruce Laurie, eds., **Class, Sex and the Woman Worker** (Westport, Conn.: Greenwood Press, 1980).

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Cowan, Ruth Schwartz. "Two Washes in the Morning and a Bridge Party at Night: The American Housewife Between the Wars," **Women's Studies** 3 (1976): 147-172.

Cowan, Ruth Schwartz. **More Work for Mother: The Ironies of Household Technology from the Open Hearth to the Microwave** (New York: Basic Books, 1983).

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Tilly, Louise, and Joan W. Scott. **Women, Work and Family** (New York: Oxford University Press, 1979).
Toffler, Alvin. **The Third Wave** (New York: Morrow, 1980).
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Vanek, Joann. "Time Spent in Housework," **Scientific American** 231 (Nov. 1974): 116-120.
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Wertheimer, Barbara Mayer. **We Were There: The Story of Working Women in America** (New York: Pantheon Books, 1977).
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SECTION II: TECHNOLOGY IN THE CONTEMPORARY WORLD

Part 1: Introduction to Technology Studies

INTRODUCTION TO SCIENCE AND TECHNOLOGY STUDIES

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COURSE DESCRIPTION

[This course was first developed and taught at the New Jersey Institute of Technology, Newark, New Jersey, in the fall of 1983, Editor]

This course has a two-fold purpose: to explore contemporary science and technology as social institutions, and to investigate the variety of perspectives from which scholars have attempted to understand the role of science and technology in society.

Anyone who reads or watches the news is continually reminded of the interactions of science, technology, and society. The discovery of dioxin contamination in a Newark neighborhood; the Environmental Protection Agency's recent announcement that New Jersey has the dubious distinction of harboring within its border the largest single producer of hazardous wastes in the country; or the crucial significance of military technology in debates over national security and nuclear defense -- these are just three examples of the myriad questions of public policy affected by science and technology. On a more positive note, the panoply of new products from the chemical industry has transformed American lifestyles, and the economic implications of high-technology industries have revitalized certain areas of the country. Technical issues have become inescapable elements of contemporary public policy, and informed citizens need to find ways to deal knowledgeably with the complexities of science, technology and human affairs.

This course is designed to impart some of that knowledge by considering a series of case studies from a variety of perspectives, including those of the historian and sociologist of science, the economist, and the political scientist. Among the topics we will examine are the social systems of science and technology; the relations of science to other subcultures in society; the manner in which scientists and engineers establish and use expertise; the patterns of technological change and their connection with economic variables; and the politics of technical decisions.

By the end of the course, we will have become familiar with a new view of science and technology as inherently cultural activities; instead of seeing technology as autonomous, or science as a privileged form of knowledge, we will see that scientific and technical choices necessarily involve social, political, and economic interests.

COURSE REQUIREMENTS

1. Texts: The following books, from which all reading will be assigned, are available for purchase in the university bookstore:

Barry Barnes and David Edge, eds., **Science in Context: Readings in the Sociology of Science** (Cambridge, Mass.: MIT Press, 1982).

Daniel Ford, **Three Mile Island: Thirty Minutes to Meltdown** (New York: Penguin Books, 1982).
Tracy Kidder, **The Soul of a New Machine** (Boston: Little, Brown, 1981).
Colin Norman, **The God That Limps: Science and Technology in the Eighties** (New York: W. W. Norton, 1981).
Nathan Rosenberg, **Inside the Black Box: Technology and Economics** (New York: Cambridge University Press, 1982).

2. Lectures and Discussions: In addition to doing the required reading, students are naturally expected to attend class and play an active role in discussion of the week's reading. Tuesday will normally be devoted to lectures, with Thursdays given over to questions and analysis of the readings. Participation in class will be a factor in determining final grades.

3. Written Assignments: Each student will prepare a 10-15 page typewritten essay on a current issue in science and technology studies (e.g., dioxin, cable TV, computers and privacy) analyzed in terms of perspectives learned in the course. An outline and bibliography will be due in week 8. A rough draft of the paper is due in week 12, and the final, revised version on the last day of classes.

4. Examinations: There will be a mid-term exam in class on October 27, and a take-home final examination due at a time to be announced. Both exams will consist of essay questions based on themes in the reading and discussion.

5. Grades: Grades will be calculated according to the following formula -- Midterm, outline, and rough draft = 40%; final exam = 30%; and final paper = 30%.

COURSE OUTLINE AND READING ASSIGNMENTS

Week 1. Introduction: Perspectives on Science, Technology, & Culture

Week 2. The Social Structure of Science
Barnes and Edge, **Science in Context**, Part I, pp. 13-64.

Week 3. The Culture of Science
Barnes and Edge, **Science in Context**, Part II, pp. 65-146.

Week 4. The Relations of Science and Technology
Barnes and Edge, **Science in Context**, Part III, 147-185.

Week 5. Technology and Economics
Rosenberg, **Inside the Black Box**, Parts I and II, pp. 3-159.

Week 6. The Cycle of Invention
Rosenberg, **Inside the Black Box**, Parts I and II, pp. 3-159.

Week 7. Technology and the Market: Commercial Aircraft and Silicon Chips
Rosenberg, **Inside the Black Box**, Part III, pp. 163-241.

Week 8. Science as Expertise: Interest Groups and "Contexts of Use"
Barnes and Edge, **Science in Context**, Parts IV and V, pp. 187-335.

Week 9. Review: Social Interests, Economics, and Scientific and Technological Change

Other works which can be introduced to students during the first half of the are the following:

David Dickson, **The Politics of Alternative Technology** (New York: Universe Books, 1975).

Dorothy Nelkin, ed., **Controversy: Politics of Technical Decisions**, 2nd ed., (Beverly Hills, Calif.: Sage, 1984).

Witold Rybczynski, **Taming the Tiger: The Struggle to Control Technology** (New York: Viking, 1983).

Langdon Winner, **The Whale and the Reactor: A Search for Limits in an Age of High Technology** (Chicago: University of Chicago Press, 1986).

Week 10 & Week 11. The Politics of Technical Controversies: The Case of Three Mile Island

Ford, **Three Mile Island**, all.

Other works which provided helpful information and perspectives for this case study:

Philip L. Cantelon and Robert C. Williams, **Crisis Contained--The Department of Energy at Three Mile Island: A History** (Washington, D.C.: U.S. Department of Energy, 1980). [DOE/EV/10278-T1]

President's Commission on the Accident at Three Mile Island, **Report ...**, (Washington, D.C.: U.S. Government Printing Office, 1979).

David L. Sills, C. P. Wolf, and Vivien B. Shelanski, eds., **Accident at Three Mile Island: The Human Dimensions** (Boulder, Colo.: Westview Press, 1982).

For general background, see:

Steven L. Del Sesto, **Science, Politics, and Controversy: Civilian Nuclear Power in the United States, 1946-1974** (Boulder, Colo.: Westview Press, 1979).

Jack M. Holl, Roger M. Anders, and Alice L. Buck, **United States Civilian Nuclear Power Policy, 1954-1984: A Summary History** (Washington, D.C.: U.S. Department of Energy, 1986. [DOE/MA-0152]

George T. Mazuzan and J. Samuel Walker, **Controlling the Atom: The Beginnings of Nuclear Regulation, 1946-1962** (Berkeley: Univ. of California Press, 1984).

Richard L. Meehan, **The Atom and the Fault: Experts, Earthquakes, and Nuclear Power** (Cambridge, Mass.: MIT Press, 1984). [For an intriguing account of a related controversy]

Week 12 & Week 13. The "Micropolitics" of Technological Design: Computers, Competition, and Strategy

Kidder, **Soul of a New Machine**, all.

For background to this case study see:

Stan Augarten, **Bit by Bit: An Illustrated History of Computers** (New York: Ticknor & Fields, 1984). [A highly readable and generally sound popular account based on thorough reading in secondary sources]

Ernest Braun and Stuart Macdonald, **Revolution in Miniature: The History and Impact of Semiconductor Electronics**, 2nd ed., (New York: Cambridge University Press, 1982).

Herman H. Goldstine, **The Computer from Pascal to von Neumann** (Princeton, N.J.: Princeton University Press, 1980).

Thomas J. Misa, "Military Needs, Commercial Realities, and the Development of the Transistor, 1948-1958," in Merritt Roe Smith, ed., **Military Enterprise and Technological Change** (Cambridge, Mass.: MIT Press, 1985).
Michael R. Williams, **A History of Computing Technology** (Englewood Cliffs, N.J.: Prentice-Hall, 1985).

On IBM and the computer industry see:
Charles J. Bashe, Lyle R. Johnson, John H. Palmer, and Emerson W. Pugh, **IBM's Early Computers** (Cambridge, Mass.: MIT Press, 1986).
Katharine Davis Fishman, **The Computer Establishment** (New York: Harper & Row, 1981).

On the Silicon Valley and recent entrepreneurial ventures in computers:
Paul Freiberger and Michael Swaine, **Fire in the Valley: The Making of the Personal Computer** (Berkeley, Calif.: Osborne/McGraw-Hill, 1984). [Nicely captures the spirit of the early microcomputer industry, and provides a useful counterpoint to Kidder's **Soul of a New Machine**]
Michael S. Malone, **The Big Score: The Billion-Dollar Story of Silicon Valley** (New York: Doubleday, 1985).
Everett M. Rogers and Judith K. Larsen, **Silicon Valley Fever: Growth of High-Technology Culture** (New York: Basic Books, 1984).

Week 14. The Politics of Science and Technology Policy: Who Benefits? Who Decides? Who Pays?
Norman, **God That Limps**, Chapters 1-4, pp. 15-142.
See also:
David Dickson, **The New Politics of Science** (New York: Pantheon, 1984).
Anne L. Hiskes and Richard P. Hiskes, **Science, Technology, and Policy Decisions** (Boulder, Colo.: Westview Press, 1986).
W Henry Lambright, **Governing Science and Technology** (New York: Oxford University Press, 1982).

Week 15. The Politics of Science and Technology Policy: Technology Transfer
Norman, **God That Limps**, Chapter 5, pp. 143-183.
Rosenberg, **Inside the Black Box**, Part IV, pp. 244-291.

Week 16. Review: Science and Technology as Democratic Institutions
Norman, **God That Limps**, Chapter 6, pp. 185-198.

ALTERNATIVE COURSE DESIGNS

This course was intended as the basic introduction for STS students in an engineering school, and the examples and readings were chosen with their needs in mind. An alternative design would be to substitute Arnold Pacey's **The Culture of Technology** (Cambridge, Mass.: MIT Press, 1981) and Richard Meehan's **Getting Sued and Other Tales of the Engineering Life** (Cambridge, Mass.: MIT Press, 1981) for Ford's **Three Mile Island** and Norman's **God That Limps**, thus providing more focus on engineering practice and less on science and technology policy.

Another possible design would be to use an anthology to provide the focus on technological practice. I would select Donald MacKenzie and Judy Wajcman, eds., **The Social Shaping of Technology: How the Refrigerator Got Its Hum** (Milton Keynes/Philadelphia: Open University Press, 1985). This collection provides a good cross-section of some of the best recent work on the history of technology,

with selections on domestic and military technology. (The overall framework is congruent with that in the Barnes and Edge collection used in the syllabus above.)

Another variant to consider would be using Barry Barnes's recent **About Science** (Oxford: Basil Blackwell, 1985) as an alternative to the Barnes and Edge reader. This would have the advantage of lightening the reading load on students, but Barnes and Edge covers a wider range of material. Any number of variations like this are possible, depending on the particular needs and predilections of students and faculty alike. The important point to keep in mind is the overall thrust of the course: students should leave with a firm understanding that science and technology are shaped not just by the array of technical options available in a given situation, but also by the social, political, and economic interests of a variety of constituencies.

SCIENCE, TECHNOLOGY AND SOCIETY

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COURSE OUTLINE

I. The Nature of Science and of Society.
   A. What is science?
   B. The relationship between science and technology.
   C. What is society?
   D. The impact of technological innovation on society (and vice versa).

II. Revolutionary Change.
   A. The Industrial Revolution.
      1. The technological revolution.
      2. The social revolution.
   B. Science and Technology in 20th Century Societies.
      1. Science in the modern world.
      2. The status of technology.
      3. Social changes and adjustments.
         a. in underdeveloped and primitive societies.
         b. in developing nations.
         c. in technologically advanced countries.

III. Science, Society, and Human Values.
   Issue oriented debates and discussions on selected topics such as communications technology, medicine, environment, population growth, energy, warfare, outer space.

IV. Planning for the Future.
   A. Models for the future.
      1. Anticipating new technology.
      2. Alternative forms of social organization.
   B. Space - new frontier, new opportunities.
      1. Space industrialization.
      2. Space colonization.

REQUIRED TEXTS

Edward Pytlik, Donald Lauda, and David Johnson, **Technology, Change and Society** (Worcester, Mass.: Davis Publications, 1978).

Joan Rothschild, ed., **Machina Ex Dea: Feminist Perspectives on Technology** (New York: Pergamon Press, 1983).

Albert H. Teich., ed., **Technology and the Future**, 4th ed., (New York: St. Martin's Press, 1986).

COURSE REQUIREMENTS

Participation in class discussions (assumes regular attendance).
Assigned readings in texts and other courses.
Varied short assignments.
Research Project: An Impact Analysis.
Mid-term Exam - Final Exam.

CLASS TOPICS AND READING ASSIGNMENTS

1. Introduction (Was There a "1984"?)

2. What is Science?
   Pytlik, **Technology, Change and Society**, ch. 1-2, pp. 3-23.

3. What is Society?
   Pytlik, **Technology, Change and Society**, ch. 3-4, pp. 24-49.

4. Impact of Technology on Society
   Handout
   Teich, **Technology and the Future**, pp. 29-30 (Alvin M. Weinberg, "Can Technology Replace Social Engineering") and pp. 99-129 (Emmanuel G. Mesthene, "The Role of Technology in Society").

5. Industrial Revolution
   Pytlik, **Technology, Change and Society**, ch. 5-7, pp. 50-109.

6. Science and Technology in the Twentieth Century

7. Science and Technology in the Twentieth Century, cont.

8. Mid-Term Exam

9. Medical Technology
   Pytlik, **Technology, Change and Society**, ch. 11, pp. 230-246.

10. Population Growth
    Pytlik, **Technology, Change and Society**, ch. 8, pp. 141-181.
    Teich, **Technology and the Future**, pp. 190-215 (Donella H. Meadows, et al., "Technology and the Limits to Growth").
    Teich, **Technology and Man's Future**, 3rd ed., (New York: St. Marin's, 1981), pp. 216-228 (Christopher Freeman, "Malthus with a Computer").

11. Environment
    Pytlik, **Technology, Change and Society**, ch. 10, pp. 210-229.

12. Energy; Technology, Work, and Leisure; Military Technology.
    Pytlik, **Technology, Change and Society**, ch. 9 and 12, pp. 182-209 and 247-265.

13. Space - The New Frontier
    Pytlik, **Technology, Change and Society**, ch. 13, pp. 266-280.

Please complete assigned readings **prior** to class during which topic will be discussed. Additional Readings will be put on reserve in library for your use.

Students should read regularly the "Science Times" section of the Tuesday **New York Times**.

COURSE ASSIGNMENTS

1. Write precise definitions of both "science" and "technology," clearly distinguishing between the two terms. (Avoid quotations if possible; rather, develop meaningful and understandable definitions. Please footnote sources, if appropriate.)
   Describe what you understand by the term "a society"?

2. Read Alvin Weinberg's article in the Teich reader. Select a social problem (one not noted in the article) and suggest both a technological and a sociological solution, or, as Weinberg would say, describe both a socially engineered solution and a technological fix.

3. Using the "Guideline for Analyzing the Impact of Science and Technology" (see below) write an impact analysis of the changes brought about by the introduction of <u>one</u> of the following into society:
   *automobile *birth control pills *radio *television
   (In your analysis be sure you include some comment on <u>each</u> of the subheadings noted in the guideline.)

4. Research Paper.
   Select as a topic a recent, current, or impending development in science or technology and analyze its impact on a society.
   Purpose: To analyze the process of social change induced by developments in science and technology.

   Students are to measure the impact of a particular scientific development or technological change on a society. In developing their analysis, students should deal with as many of the dimensions of the "Guideline for Analyzing the Impact of Science & Technology on Society" (see below) as are relevant to the topic. The more specific the topic the easier the analysis. Students may chose to do research on:

   (1) a scientific or technological change which has already taken place and has had a measurable impact on society (e.g., rocketry, nuclear energy);

   (2) a scientific or technological development which has occurred in some modern industrial societies but has only recently been introduced into another industrial society with a different social, cultural, political, or economic system (e.g., sports medicine, private automobiles) or into an underdeveloped society (e.g., population control devices, television);

   (3) recent developments in science and technology either in experimental stages (e.g., space colonies) or not yet broadly applied in society (e.g., genetic engineering, personal computers).

   The issues listed in Part II of the Pytlik text would be a useful starting point for identifying some broad areas from which students could delimit a scientific problem for analysis. The course bibliography (attached) is a good resource.

Throughout the semester students are expected to participate in and are encouraged to lead class discussions on the topics of their research.

Topic Approval

Students should consult with Ms. Cutolo [and/or Dr. Miranda] by the tenth week of the class at the latest for approval of the topic and specific suggestions for further research.

Grading: All research papers will be read and graded by both instructors.

Due Date: **Final Papers are due the fourteenth week of class.**

Students are encouraged to complete and submit papers before this date. Regardless of date of submission of final paper, students are expected to share the findings of their research during class discussions throughout the semester.

GUIDELINE FOR ANALYZING THE IMPACT OF SCIENCE & TECHNOLOGY ON SOCIETY

In analyzing the impact of any change, note the following:

1. Scientific and technological environment:
   a. What is the status of the technology in the area of study? (experimental stage, tested but not yet marketed, advanced technology with broad areas of application)
   b. Was the particular development (under study) a response to a "felt need" of society, or an application, or a by-product of other research (serendipity)?
   c. From what sources did research in this area have financial support (government, industry, private foundations)?

2. The innovators:
   a. Who are they? (scientists, industrial researchers, inventors).
   b. What is their role and position in society?
   c. How will acceptance or rejection of the innovation be influenced by "b" above?

3. Communication:
   a. How was innovation introduced into the society?
   b. How and by whom was this innovation communicated to the society?

4. Social-cultural environment:
   a. Is the innovation compatible with existing patterns (norms, values, expectations), a logical development from existing patterns, or the direct antithesis of existing patterns?
   b. What existent forces in society are conducive to acceptance of this change?
   c. What existent forces in society are directed against acceptance?

5. Social relationships:
   a. Which groups will be most directly affected by this change? How?
   b. What other groups, institutions, etc., might be affected by this change?

c. What adjustments would have to be made in other sectors of life, if this innovation were accepted by society?

6. Stress, strain or equilibrium:
   a. What are the manifest functions of the innovation?
   b. What are the latent functions of the innovation?
   c. Will the innovation produce a stress or strain in the society, or is it intended to return society to a state of equilibrium?
   d. Is the innovation a fairly self-contained one, or will it set in motion a chain reaction throughout the society?

7. Physical environment:
   a. Will this change have any impact on the physical environment?
   b. If so, specify the positive and/or negative effects on the physical environment?
   c. What segments of society will be most affected by these changes?
   d. How might these segments of society respond to the original innovation which brought about these environmental changes?

8. Acceptance or rejection:
   Given sufficient trial time, do you see greater acceptance or rejection of the innovation? Explain.

N.B. This is offered merely as a guideline. It does not have to be followed exactly, nor must each question be answered separately. It is suggestive of the content expected in the analysis of the process of social change.

MID-TERM EXAM

Directions: Do not write out your answers to this test at home. Rather, think about the implications of the issues raised. Answers are to be written out in class (without references to notes) at the time scheduled for the mid-term exam.

Part I. Select three (3) of the following statements. For each write a well developed essay explaining whether you agree or disagree with the statement. (While students may express their own opinions, answers should reflect an awareness of basic themes and issues presented in the course, and essays should include their recognition and understanding of opposing viewpoints.)

(1) The goals of science are antithetical to the interests of society.
(2) Increasing scientific and technological development means decreasing individual freedom.
(3) Technology is a response to needs as well as a creator of needs.
(4) Society is so often victimized by the negative effects of technology because there is no communication between the scientist and society.
(5) Society can have only minimal effect on developments in science and technology.
(6) Appropriate technology hurts developing countries by denying them access to the high levels of technology they need for their development.

Part II. The purpose of this section is to measure your understanding of the process of social change. You are asked to analyze the impact of a particular change on society. In answering, deal with as many of the dimensions of change as possible. Be imaginative; speculate but keep responses in the realm of the reasonable.

Select one of the following situations and discuss the impact it would have on American society. (The guidelines distributed in class might prove useful for the analysis.)

(A) Assume there is a major breakthrough in molecular biology - scientists discover simple techniques in gene modification enabling total determination and control of the characteristics of a human baby. While this technique may become a reality, society has not come to a consensus regarding its appropriate use.

(B) An unexpected major solar activity irradiates the earth with large amounts of ultra-violet and high energy particle radiation. About 50% of the world's population becomes totally blind, with an additional 25% becoming partially blind with the possible loss of sight in the near future if not immediately treated.

FINAL EXAMINATION

Directions: Answer three (3) of the following questions. Answers should be substantive responses to the questions asked and clearly reflective of the major issues raised in this course.

1. The final chapter of the Pytlik text and several articles (Porter and Drucker) in the Teich reader discussed technology assessment.

a. What is technology assessment?
b. Why is technology assessment so important in preparing for the future of our life in this world?
c. Describe, in general terms, the process of technology assessment.

2. Discuss the population problem in terms of deliberate attempts to change birth rates and death rates in both the developed and developing worlds. What institutions in societies are most influential in affecting population growth? EXPLAIN.

3. Discuss the energy problem in terms of: (a) long and short term availability of various energy sources and (b) impact of various energy sources on the environment.

4. Describe and discuss some of the major social and ethical issues raised by the availability and use of advanced medical technology. (In answer to this question, do not discuss the technologies, but rather the social and ethical issues raised by the range of technologies developed.)

5. Discuss the impact of the technology developed for and utilized in the space program on man's understanding of himself, his environment (physical, social, and political), and the quality of his life.

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UNDERSTANDING TECHNOLOGY: AN INTRODUCTION TO TECHNOLOGY STUDIES

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COURSE GOALS

This course is designed to achieve three general goals, as follows:

(1) provide the student with a better understanding of the ways in which technology and society interact with each other;

(2) give the non-engineering student an improved grasp of the workings of technology, so as to be better able to approach issues relating to technology in a fashion which is both technically and humanistically sensitive;

(3) inform the student regarding the issues and procedures involved in public policy decisions about technology.

This course begins with some general information aimed at describing and locating technology and technology studies in the midst of other topics and disciplines. The course then moves on to consider the interaction of technology and society, initially in a somewhat general fashion (weeks 2 and 3). The technology/society interaction is then developed more specifically by looking at the impact on society of changes in transportation. Following this, the course focuses on a specific aspect of transportation technology -- traffic control systems -- beginning with 19th century railway signaling devices. This technology is treated as a type of information processing technology. Thus students in effect learn some of the theoretical basics of information processing systems. (For example, they are able to see that different pieces of hardware [electromechanical relays, silicon chips, etc.] can be viewed as performing the same information processing task, and that a given piece of hardware -- a 19th-century railway interlocking system -- can be interpreted as performing a variety of information processing tasks.) Likewise, they are exposed to a number of basic technological concepts (e.g., system, information, feedback, etc.). (The ultimate goal here is to help demystify the workings of a diverse range of technological systems.) Having thus introduced students to the technology-society interaction and some of the more technical features of technology, the course then examines a number of issues in technological decision-making. It concludes with an examination of some specific technology assessments regarding transportation policy.

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Turing, Alan. "Computing Machinery and Intelligence," **Mind** 59 (1950): 433-460.
Turkle, Sherry. **The Second Self: Computers and the Human Spirit** (New York: Simon and Schuster, 1984).
Weizenbaum, Joseph. **Computer Power and Human Reason** (New York: W. H. Freeman, 1977).
Winner, Langdon. **Autonomous Technology: Technics Out-of-Control as a Theme in Political Thought** (Cambridge: Cambridge University Press, 1977).

COURSE OUTLINE

(Reading assignments are given in brackets. Full citations are given in the reading above.)

Week 1: Introduction: Components of the Technological World

* engineering, applied science, and pure science: similarities and differences [Billington, **Tower and Bridge**, pp. 8-13, 41-44, 135-138]
* the organizational/systems element in technology [handout by instructor]
* the role of social context in understanding technology [handout by instructor]

Week 2, 3: Servant Technology vs. Autonomous Technology

* technology as servant [Florman, **Existential Pleasures**, ch. 1-6, pp. 3-90]
* autonomous technology, technological determinism [Winner, **Autonomous Technology**, ch. 1-2, pp. 13-106]
* values in technological practice; the contextual relativity of evaluations of technology [Pacey, **Culture of Technology**, ch. 1-3 and 5-7, pp. 1-54 and 78-136]

Week 4: The Social Impact of Technology, Part I -- The Technological Self-Image of Humanity

* the image of systems and control -- the 1939 New York World's Fair [Meikle, **Twentieth Century Limited**, ch. 9, pp. 189-210]
* the information processing image of humanity [Turkle, **Second Self**, Introduction, ch. 1, pp. 11-63]
* possibly bogus appeals to technical expertise [MacIntyre, **After Virtue**, ch. 7, pp. 79-87; Dreyfus & Dreyfus, **Mind Over Machine**, ch. 6, pp. 158-192]

Week 5- The Social Impact of Technology, Part II -- Transportation and American Culture

* the railroad as an extension of urban society
* the creation of industrial zones and suburbs; "the other side of the tracks"
* development of related industries (e.g., electrical power systems)
* new technologies: signal systems as 19th-century information processing machines
* new hazards (e.g., grade crossings)
* new perceptions of space and time
* right-of-way aesthetics; railroads and landscape architecture
* the role of the small town station
* changing patterns of commerce

[Stilgoe, **Metropolitan Corridor**, ch. 1, 3-8, 10, 12-13, pp. 3-45, 73-243, 263-283, 311-345]

Week 8: Information Systems, Part I -- An Introduction to Basic Technological Concepts (e.g., system, feedback, information) through Traffic Control Systems

* a problem in transport systems: traffic control when stopping distance exceeds sighting distance [Stilgoe, **Metropolitan Corridor**, ch. 5-6, pp. 105-161]
* early 19th-century rail traffic control systems (timetables, train orders, and mechanical signals)
* automatic control systems:
  - -basic electrical concepts (circuits, relays, etc.)
  - -early automatic block signals
  - -mechanical and electromechanical interlocking systems
  - -pulse coded track circuits

[Armstrong, **The Railroad**, pp. 101-123; Hay, **Introduction to Transporation Engineering**, ch. 11, pp. 414-441; Paquette, **Transportation Engineering**, ch. 5, pp. 144-151]

Week 9-10: Information Systems, Part II -- Signals, Circuits, and Logic: Alternative Embodiments and Interpretations of Digital Systems

* two-valued logic and logic machines [handout by instructor]
* alternative physical embodiments of the same idealized logic machines; electromechanical interlockings and electronic computers [handout by instructor; Weizenbaum, **Computer Power**, ch. 2-3, pp. 39-110]
* logic, language, and the technological image of humanity [Turing, "Computing Machinery" and Searle, "Minds, Brains"]
* computer lab on logic machine design [Rocky's Boots, Robot Odyssey]

Week 11-15: Risk, Technology, and Public Policy

* methodological issues in risk assessment (e.g., alternative decision procedures and attitudes toward risk, alternative methods of probability measurement) [Fischhoff, **et al.**, **Acceptable Risk**, ch. 1-7, pp. 1-133]

* methodological and evaluative issues in technology assessment (the possibility of ethical neutrality; partial vs. complete quantification; distributive issues; problem definition) [Shrader-Frechette, **Science Policy**, ch. 1, 3-5.3, 6-7.3, pp. 3-31, 67-130, 152-230]
* transportation technology assessment case studies (high-speed rail; state-financed Amtrak service; state-financed branch line rehabilitation) [Congressional Office of Technology Assessment, **Passenger Rail Technologies**; Iowa Railway Finance Authority, **Feasibility of Rail Passenger Service**; Iowa Department of Transportation, **Iowa Transport Improvement Program**]

ADDITIONAL INFORMATION

During week 10 students design logic machines to perform a variety of tasks. This is accomplished using the "Rocky's Boots" and "Robot Odyssey" software available from The Learning Company, Inc., 545 Middlefield Road, Menlo Park, CA 94025. These are available for about $35 each from software discounters. Using representations of simple logic machine types (conjunction, disjunction, etc.) which appear on the computer screen, students "wire" the machines. If properly "wired," the machines will successfully "perform" their intended task on the screen (e.g., sorting colors, counting, searching for an object, etc.).

This course has been intentionally designed in modular fashion, so that material in some way related to technology can be easily exported to other settings. (This is part of a broader goal of exposing as many students as possible to at least one aspect of technology studies.) Thus, for example, the material dealt with in weeks 1-4 has also been used in a philosophy of natural science course (in part to clarify the relationship of science and technology, and in part because similar issues of autonomy and servanthood are raised regarding science). Similarly, the material for weeks 8-10 has also formed part of a course in formal logic, so that students start to think of technology not just in terms of artifacts such as machines and structures, but also in terms of processes and systems which, however diverse their physical instantiations, can be viewed abstractly as having a number of common elements.

Although the use of transportation technology as a focal point in weeks 5-7 ties in well with the focus on traffic control systems in weeks 8-10, one might of course substitute a different technology and alternative set of issues in weeks 5-7.

SECTION II: TECHNOLOGY IN THE CONTEMPORARY WORLD

Part 2: Technology Literacy

UNDERSTANDING TECHNOLOGY

Joseph D. Bronzino
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Hartford, Connecticut

COURSE OBJECTIVES

We live in a technological society, one in which technology has simultaneously improved our lives and created significant problems. The rapid acceleration of technological innovation during the past 30 years has created a significant "knowledge gap" between the creators of these technological devices and the users or consumers of these products. Since any creation, tool, device must be understood in order for it to be properly utilized, it has become important that the art of technology be understood not only by engineers but by humanists as well. With this broad goal in mind, this course has the following objectives:

(1) to enable liberal arts students to understand some of the basic concepts underlying certain areas of technological activity, e.g., the operation of the heat engine; the telegraph, telephone, and television; the composition of different chemicals and materials, etc.

(2) to provide an opportunity for students to examine and discuss the social impact of technology, e.g., the British and American industrial revolutions, the energy alternatives available to our society, the creation and reduction of pollution, the possibilities of creating bionic humans, genetic engineering, etc.

(3) to permit students to explore the myths associated with one of the most renowned American inventors -- Thomas Alva Edison -- in an effort to better understand the driving force within modern technological innovators.

Since the range of topics is quite extensive (see course schedule and outline of material to be covered), we utilize a seminar format with a faculty coordinator who serves as the course organizer and discussion leader for the students. Faculty members from physics, chemistry, engineering, and history of science actively participate in this course by presenting specific lectures on various topics of interest (see course schedule). This approach provides students with both an in-depth coverage of specific areas and consistency in style and format in the discussion sessions.

PRIMARY TEXTS

Joseph Bronzino, **Computer Application for Patient Care** (Menlo Park, Calif.: Addison Wesley, 1982).
Samuel Florman, **Blaming Technology** (New York: St. Martin's Press, 1981).
Samuel Florman, **The Existential Pleasures of Engineering** (New York: St. Martin's Press, 1976).
Wyn Wachhorst, **Thomas Alva Edison: An American Myth** (Cambridge, Mass.: MIT Press, 1982).

COURSE SCHEDULE
[Note: "Class Dialogue" sessions follow each portion of the course.]

PART I: INTRODUCTORY CONCEPTS

1. Introduction to the Course

2. Technology: A Definition

3. Examples of Technological Innovation

Readings for Part I

P.L. Bereano, "The Nature of Technology," in P. L. Bereano, **Technology As a Social and Political Phenomenon** (New York: John Wiley and Sons, 1976) pp. 5-14.
Lewis Mumford, "The Automation of Knowledge," **ibid.**, pp. 24-34.
William F. Ogburn, "The Meaning of Technology," **ibid.**, pp. 15-20.
Manfred Stanley, "Technology and Its Critics," **ibid.**, pp. 20-24.
Daniel Yankelovich, "Science and the Public Process: Why the Gap Must Close," **Issues in Science and Technology** 1 (Fall 1984): pp. 6-12.

PART II: WESTERN TECHNOLOGY - A HISTORICAL PERSPECTIVE

4. The Industrial Revolution
   *technology and science
   *origin of the phrase "Industrial Revolution" (1804 in France)
   *traditional views (I.R. begins in Britain in 1769 -- Watt and Arkwright); Landes's definition
   *later industrial revolutions

5. The Steam Engine
   *Watt and the separate condenser
   *Sadi Carnot and the efficiency of an ideal steam engine
   *high pressure steam engines
   *the explosion problem
   *social and political consequences of steam transportation
   *the distortions of "progressive" or "present minded" history

6. The Process of Industrialization
   *Britain: cotton, iron, coal, chemicals, machine tools, the factory system
   *the "American system of manufactures": specialized machines, standardization, interchangeable parts

Readings for Part II

History Today 33 (April 1983): special issue on Industrial Revolution.
Duncan Bythell, "Cottage Industry and the Factory System," pp. 17-23.
Martin Daunton, "Toil and Technology in Britain and America," pp. 24-29.
Barrie Trinder, "Ironbridge: The Cradle of Industrialization," pp. 30-34.
History Today 33 (May 1983): special issue on Industrial Revolution.
R. J. Morris, "Class and Common Interest," pp. 31-35.
Roderick Floud, "A Tall Story? The Standard of Living Debate," pp. 36-40.
K. Z. Cieszkowski, "Joseph Wright of Derby: Painter of the Industrial Revolution," pp. 41-46.
David Landes, **The Unbound Prometheus** (Cambridge: Cambridge University Press, 1969) ch. 2, pp. 41-123.

Otto Mayr and Robert Post, eds., **Yankee Enterprise: The Rise of the American System of Manufactures** (Washington, D.C.: Smithsonian Institution Press, 1981).
Terry S. Reynolds, "Medieval Roots of the Industrial Revolution," **Scientific American** 251 (July 1984): 122-130.

PART III: ENERGY AND SOCIETY

7. What is Energy?
   - *a technical definition of "energy" from thermodynamics
   - *the difference between mechanical and thermodynamic energy
   - *a discussion of the first and second laws of thermodynamics
   - *a definition of entropy

8. How is Energy Used Today?
   - *sources of energy
   - *resources available

9. How is Energy Generated?
   - *hydroelectric power
   - *fossil-fuel steam electric power (a detailed discussion of the historical development of steam power is presented)
   - *nuclear fission
   - *nuclear fussion

10. What is the Outlook for "Energy" in the Future?

Readings for Part III

W. Clark, **Energy for Survival** (New York: Anchor Books, 1975).
Cynthia Owen Philip, "Robert Fulton: An American Leonardo da Vinci," **Mechanical Engineering** 107 (November 1985): 44-54.
Cynthia Owen Philip, "Robert Fulton: In Search of Fame and Fortune," **Mechanical Engineering** 108 (May 1986): 78-85.
T. J. Healy, **Energy, Electric Power, and Man** (San Francisco: Boyd & Fraser, 1974).
H. T. Odum and E. C. Odum, **Energy Basis for Man and Nature** (New York: McGraw-Hill, 1976).
M. L. Shepard, J. B. Chaddock, F. H. Cocks, and C. M. Harman, **Introduction to Energy Technology** (Ann Arbor, Mich.: Ann Arbor Science Publishers, 1976).

PART IV: MATERIALS OF TODAY AND TOMORROW

11. Characteristics of Materials
    - *ductile vs. brittle
    - *good thermal conduction vs. poor
    - *transparent
    - *good electrical conduction vs. poor

    Principal Classes of Materials
    - *plastics (polymers)
    - *ceramics
    - *metals

12. Atomic Bonding
    - *co-valent bond
    - *ionic bond
    - *metallic bond

    Relation of Properties to Position of Atoms in Periodic Table

13. Recent Developments in Materials
    - *semiconductor electronics
    - *optical transmission via light fibers
    - *materials substitutions - plastics for metals

Readings for Part IV:

Kenneth E. Borst, "Characteristic Properties of Metallic Crystals, **Journal of Educational Modules for Materials Science and Engineering** 4, no. 3 (1982): 457-492.

Scientific American 255 (October 1986): entire issue on theme "Materials for Economic Growth."

PART V: BASIC CONCEPTS OF ELECTRICAL SCIENCE

14. Basic Concepts of Electrical Science
    - *conductors, semiconductors, insulators
    - *current and voltage: pressure-flow analogy, Ohm's Law
    - *application of simple circuit: telegraph system, Morse Code
    - *acoustic waves, electromagnetic waves; wavelength and frequency
    - *demonstration telegraph circuit and coding demonstration

15. Electrical Devices: Telegraph, Telephone, Television, and Beyond
    - *microphones and speakers
    - *definition of information
    - *telephone systems
    - *radio transmission
    - *amplitude modulation and frequency modulation (theory and demonstration)
    - *demonstration of a simple A.M. radio transmitter; local (in the building) transmission of voice over radio

16. Student Oral Presentations on Contributors to Electricity and Electrophysics
    The following individuals made (or continue to make) significant contributions to the field of electricity, electronics, and communications. Each class member will present a seven-minute capsule summary of the technical contributions of one of these persons and of the context in which he worked. Presentations will be in the order listed below. Indicate your choice (first, second, and third choice).
    1. Benjamin Franklin
    2. Alexander Graham Bell
    3. Guglielmo Marconi
    4. Lee DeForest
    5. Edwin Armstrong
    6. Harry Black
    7. William Shockley
    8. Robert Noyce
    9. Carver Mead

Readings for Part V:

T.S.W. Lewis, "Radio Revolutionary [about Edwin Armstrong]," **American Heritage of Invention and Technology** 1 (Fall 1985): 34-42.

PART VI: COMPUTERS

17. The Computer: Historical Perspective
    - *historical perspectives
    - *history of calculating devices

18. Basic Principles of Computer Operation

19. Computer Applications
    - *the era of the computer

Readings for Part VI:

Stan Augarten, **Bit by Bit: An Illustrated History of Computers** (New York: Ticknor & Fields, 1984).

Michael R. Williams, **A History of Computing Technology** (Englewood Cliffs, N.J.: Prentice-Hall, 1985).

PART VII: POLLUTION

20. Pollution: Technical Aspects
    - *pollution in our industrial society
      - changing technological approach; driving forces for change
    - *principles of equilibrium
      - theory; example of simple equilibrium; pollution and ecological equilibria
    - *types of hazards from pollution
      - types of pollution
        - poisons and toxins
        - air pollution
        - water pollution
      - hazards from pollution
        - water cycle in the environment
        - biotechnology and pollution - a new definition
        - dose-response relationships - estimates of hazard

22. Pollution: Societal Concerns
    - *lead pollution - a simple problem
      - historical lead pollution
      - lead toxicity
      - solutions
    - *formaldehyde - complex economic value judgments
    - *agriculture
      - crop yield enhancement
      - crop protection chemicals
      - biotechnology
      - land management-erosion
      - energy consumption
    - *energy production, carbon dioxide, and climate
      - fossil fuels (carbon dioxide and the greenhouse effect)
      - nuclear energy (radioactive pollution and waste disposal)
      - fusion energy and radioactive waste
      - renewable resources
    - *nuclear war - the ultimate pollution

Readings for Part VII:

P. L. Adkisson, **et al.**, "Controlling Cotton's Insect Pests: A New System" **Science** 216 (April 2, 1982): 19-22.

W. F. Alman, "Staying Alive in the 20th Century," **Science 85** 6 (October 1985): 30-37.

B. N. Ames, "Dietary Carcinogens and Anticarcinogens," **Science** 221 (Sept. 23, 1983): 1256-1264.

N. A. Ashford, C. W. Ryan, and C. C. Caldart, "Law and Science Policy in Federal Regulation of Formaldehyde," **Science** 222 (Nov. 25, 1983): 894-900.

"Carbon Dioxide Emissions," **Science** 222 (Nov. 25, 1983): 879.

D. J. Crawford and R. W. Leggett, "Assessing the Risk of Exposure to Radioactivity," **American Scientist** 68 (Sept.-Oct. 1980): 524-536.

J. Hansen, **et al.**, "Climate Impact of Increasing Atmospheric Carbon Dioxide," **Science** 213 (Aug. 28, 1981): 957-966.

W. E. Larson, F. J. Pierce, and R. H. Dowdy, "The Threat of Soil Erosion to Long-Term Crop Production," **Science** 219 (Feb. 4, 1983): 458-465.

L. B. Lave and E. P. Seskin, "Epidemiology, Causality, and Public Policy," **American Scientist** 67 (March-April 1979): 178-186.
E. Marshall, "EPA Faults Classic Lead Poisoning Study," **Science**, 222 (Nov. 25, 1983): 906-907.
E. Marshall, "The Politics of Lead," **Science** 216 (April 30, 1982): 496.
E. Marshall, "Yellow Rain Experts battle over Corn Mold," **Science** 221 (Aug. 5, 1983): 526-529.
V. I. Pye and R. Patrick, "Ground Water Contamination in the United States," **Science** 221 (Aug. 19, 1983): 713-718.
D. M. Settle and C. Patterson, "Lead in Albacore: Guide to Lead Pollution in Americans," **Science** 207 (March 14, 1980): 1167-1176.
M. Shodell, "Risky Business," **Science 85** 6 (October 1985): 42-47.
B. J. Skinner and C. A. Walker, "Radioactive Wastes," **American Scientist** 70 (March-April, 1982): 180-181.
J. D. Spengler and K. Sexton, "Indoor Air Pollution: A Public Health Perspective," **Science** 221 (July 1, 1983): 9-17.
A. Wildavsky, "No Risk is the Highest Risk of All," **American Scientist** 67 (Jan.-Feb., 1979): 32-37.

PART VIII: BIOMEDICAL AND GENETIC ENGINEERING

23. Biomedical Engineering
    *a marriage of disciplines
    *current activities
    *consequences of biomedical engineering

24. Genetic Engineering: Tinkering With Life
    *What are individual and societal breeding?
    *societal concerns - Where are the controls?

25. Public Confidence and Trust: Is it Warranted?

Reading for Part VIII:

J. D. Bronzino, "Moral and Ethical Issues of Technology and Medicine," in J. D. Bronzino, ed., **Technology and Medicine** (St. Louis: C. V. Mosby, 1977), pp. 217-242.
J. D. Bronzino, V. H. Smith, and M. L. Wade, "Evolution of American Health Care Technology: Economic and Ethical Implications," **IEEE Engineering in Medicine and Biology Magazine** 5 (September 1986): 5-10.

STUDENT ASSIGNMENTS

Short Papers

1. Select a technological innovation implemented in the United States since 1840 and:
   a) describe its basic operating principles
   b) describe what you would do then if you had the foresight to predict its impact upon society.

2. Explain and distinguish between the "myth of the garden" and the "myth of the machine."

3. Provide three applications of computers within our society and relate how each affects your own personal life.

Term Paper No. 1

Provide a historical sketch of an American technological innovation introduced after 1840. Include the following:

(1) a description of the social and political climate at the time of the invention or discovery (i.e., the soil in which the seed was planted),

(2) a description of the technological discovery or device (include figures if necessary),

(3) a general analysis or overview of the impact of this technological innovation including discussion of creation of other industries, etc. Provide this overview at intervals of twenty years (data pertaining to consumption, i.e., number of devices used, produced, etc.),

(4) a concluding statement regarding the importance (significance) of this technological innovation.

Term Paper No. 2

Samuel C. Florman's two books **The Existential Pleasures of Engineering** and **Blaming Technology** describe the decline in the status of the engineer during the years since 1950 and the concurrent emergence of an anti-technological backlash that threatens to retard technological creativity. After reading these books:

(1) Provide a list of societal concerns that have arisen as a result of technological innovation since 1940. In addition provide a list of benefits, i.e. direct positive aspects or side effects of technological innovations for the same period. (You may elect to provide lists for particular fields of activity, e.g., medicine, standard of living, environment, etc.).

(2) Provide a historical sketch of the activities of the anti-technological movement during this period. (You may include newspaper clippings to illustrate the demonstrations or political actions undertaken by this group.)

Are Florman's arguments convincing enough to affect your own view of technology, i.e., make your positive or negative views more so, or convince you to change positions? Discuss your own views taking into account his arguments.

Term Paper No. 3

Using the article "Moral and Ethical Issues of Technology in Medicine" as a guide, select an issue such as:

1. Euthanasia
2. Human Experimentation
3. Abortion
4. The Living Will

and provide arguments to support your own views regarding the role technology plays in one of these areas.

ISSUES IN HEALTH CARE IN A TECHNOLOGICAL SOCIETY

David L. Hogenboom Stephen E. Lammers
Department of Physics Department of Religion
Lafayette College
Easton, Pennsylvania

COURSE OBJECTIVES

This course has two basic objectives. The first objective is to acquaint the student with examples of technology applied to health care. We will start with an examination of "windows into the human body" from the stethoscope to x-rays and x-ray computed tomography. By studying some of the basic principles upon which these machines depend, students will learn how they work in sufficient detail to appreciate the advantages and disadvantages of one technique as compared with another. We will then focus in some detail on a new diagnostic technology (nuclear magnetic resonance imaging) and on hemodialysis, one of the treatment options for persons suffering kidney failure. Both of these technologies have become controversial, partly because of their cost. In the case of hemodialysis, 80% of that cost is borne by federal financing.

The second objective of this course is to place these technologies within a larger revolution in health care. This course will explore some of the implications of this larger technological change, including questions such as the following:

1. How have health care technologies changed the relationship between the patient and the physician? What are the implications of this for the future?

2. How does health care technology impact upon other parts of the health care system? What are the implications for the cost of health care?

3. What efforts are necessary to control the cost of health care? Should these include attempts to control the development of health care technologies in new ways? If so, how? If not, should there be new attempts to limit the distribution of these technologies? If so, how? If not, what are the implications of this decision for the future?

4. These technological advances have extended life, but the quality of the additional years is often not high. How has our attitude toward illness and death been affected by these "interventions," and what are the implications for the future of a growing population of people "maintained" by machines?

Enrollment will be limited to twenty seniors. In case of over-enrollment, final selection will be made by the instructors. No prerequisites. 3 credits.

CLASS EXPECTATIONS

Attendance

Students are expected to attend all class sessions and class trips. If you are forced to miss a class or trip you should inform one of us beforehand, if possible, and you will be expected to present an excuse from the Dean's Office upon your return to class.

Formula for Computing Your Final Grade

There will be two 75-minute examinations and a final examination in this course. Each will contribute 20% toward your final grade. There will also be a study project culminating in a 12-18 page paper worth 20%. The HUMAN PC exercise [see session 13 below] is worth 5%. The remaining 15% will be earned by participation in class discussions.

Examinations

The first exam will be on the several technologies used in medical diagnosis and related issues discussed in the first five weeks of the course. Approximately half of the test will consist of questions or problems with numerical solutions. (You will have been given practice with similar problems in class.) The second exam, on kidney disease, hemodialysis, and associated issues will be somewhat less quantitative. The final exam will concentrate on the last four weeks of the course, but some questions may require you to synthesize ideas and themes that were introduced earlier.

Project and Major Paper

After study and discussion of several specific technologies for producing images used in clinical diagnosis and the technology of kidney disease therapy, you will be asked to choose another example of medical technology to examine, using what you have learned in this course. We will suggest several topics, and you will be encouraged to think of others. Your research will result in a paper of at least 12, but no more than 18, pages in length when typed double spaced. In it you will explain in some detail how the technology works, its clinical use, its advantages and drawbacks, and its social consequences. There are two deadlines to meet: your topic, a brief outline, and major references will be due _____; the completed paper must be submitted by 5:00 p.m. on _____.

COURSE OUTLINE AND ASSIGNMENTS

[This semester-length course meets bi-weekly, Editor]

1. Introduction to the Course. Early Health Care

   Introduction to the goals and format of the course. Medical practice before the stethoscope. Autopsy. Physician-patient relationship in the 17th and 18th centuries. Early hospitals.

   Stanley Joel Reiser, **Medicine and the Reign of Technology** (Cambridge: Cambridge University Press, 1978), ch. 1, pp. 1-22.

2. Early Diagnostic Techniques

   The invention of the stethoscope and auscultation. New focus on disease as a localized pathological condition. Change in methods of treatment. Effect of the new technology on physician-patient relationship. The discovery of x-rays by Roentgen in 1895.

   Reiser, **Medicine and the Reign of Technology**, ch. 2-3, pp. 23-68.

3. X-ray Imaging

   The electromagnetic spectrum. X-ray radiography as a diagnostic technique. Tissue damage by x-radiation. Computed tomography (CT)-technique, clinical use, drawbacks.

   R. Gordon, G. T. Herman, S. A. Johnson, "Image Reconstruction from Projections," **Scientific American** 233 (Oct. 1975): 56-68.

Arthur C. Upton, "The Biological Effects of Low-Level Ionizing Radiation," **Scientific American** 246 (Feb. 1982): 41-49.
Godfrey N. Hounsfield, "Computed Medical Imaging," **Science** 210 (Oct. 3, 1980): 22-28.

4. Tour, Easton Hospital Radiology Facility
Demonstration of x-ray computed tomography by radiologist.

5. Discussion of Hospital Tour
Attention to relationship of physician and patient in light of Reiser. Further information on whole body scanners.

6. Magnetic Resonance Imaging, Pt. I
Overview of Magnetic Resonance Imaging (MRI). Basic principles of nuclear magnetic resonance (NMR). Properties of magnetic nuclei, behavior of nuclear spins in a steady magnetic field including Larmor precession and energy quantization. Spin lattice relaxation and T1.
Stuart W. Young, **Nuclear Magnetic Resonance Imaging: Basic Principles** (New York: Raven Press, 1984), ch. 1-4, pp. 1-24.
Ian L. Pykett, "NMR Imaging in Medicine," **Scientific American** 246 (May 1982): 78-88.

7. Magnetic Resonance Imaging, Pt. II
Basic principles of NMR II - interaction of spins and an imposed radio frequency (rf) magnetic field, 90 degree rf pulse, the rotating reference frame and resonance, free induction decay, spin-spin relaxation, rf pulse sequences, and spin-echo measurement of T2.
Young, **Nuclear Magnetic Resonance Imaging**, ch. 5, pp. 25-56.

8. Magnetic Resonance Imaging, Pt. III
Review of NMR theory. Magnets and other hardware. Imaging techniques - field gradients, spatial encoding, Fourier transform NMR. Clinical use of MRI and comparison with other imaging techniques.
Young, **Nuclear Magnetic Resonance Imaging**, ch. 6-10, pp. 57-137.

9. Visit to MR Imaging of Morristown, N.J.
This is a Technicare scanner site. Demonstration by the technician who is site manager followed by discussion.

10. Discussion of Site Visit
Comparisons of the various diagnostic technologies we have discussed and future developments. The effect of these technologies on the physician-patient relationship.

Preparation for hour exam.
Reiser, **Medicine and the Reign of Technology**, ch. 8, pp. 158-195
Lewis Thomas, **The Youngest Science** (New York: Bantam Books, 1983).

11. Kidney Function
Lecture by Charles Holliday of the Department of Biology on the structure and function of the kidney.
John P. Merrill, "The Artificial Kidney," **Scientific American** 205 (July 1961): 56-64.

Arthur J. Vander, **et al.**, **Human Physiology: The Mechanisms of Body Function**, 3rd ed., (New York: McGraw Hill, 1984), ch. 13, ("Regulation of Water and Electrolyte Balance").

12. Hour Exam I

13. Hemodialysis
What does a dialysis machine do for a patient; how do dialysis machines work.
R.J. Wineman, "Overview of Chronic Replacement of Kidney Function," in Fernando Villarroel and Robert L. Dedrick, eds., **Chronic Replacement of Kidney Function**, AIChE [American Institute of Chemical Engineers] Symposium Series, 187 (1979): 1-9.
Edward G. Lowrie and Clark K. Colton, "Hemodialysis: Physical Principles and Technical Considerations," in B. M. Brenner and F. C. Rector, eds., **The Kidney**, 2nd ed., (Philadelphia: Saunders, 1981), pp. 2425-2431.

Distribution of assignment in HUMAN-PC. This is a mathematical model of the human body. It is used to teach medical students the body's responses during treatment. It has a subroutine which permits the student to give a patient kidney disease and then to dialyze the patient. It is available from Professor James E. Randall, 609 South Jordan Avenue, Bloomington, Indiana 47401.

14. The Patient on Hemodialysis
Mary Elizabeth O'Brien, **The Courage to Survive** (New York: Greene & Stratton, 1983), pp. 11-69.

15. Visit to Easton Artificial Kidney Center
Presentation by R.N. site manager and social worker

16. Social Consequences of Hemodialysis, Pt. I
Discussion of kidney dialysis facility tour. Development of selection committees; federal funding for end-state renal disease (ESRD); growth of privately financed center dialysis; incentives currently in place for the treatment of ESRD.
Richard Rettig, "The Policy Debate on Patient Care Financing for Victims of End-State Renal Disease," **Law and Contemporary Problems** 40, no. 4 (1976): 196-230.
Arthur Caplan, "Kidneys, Ethics and Politics: Policy Lessons of the ESRD Experience," **Journal of Health Politics, Policy and Law** 6 (Fall 1981): 488-503.

17. Social Consequences of Hemodialysis, Pt. II
Cultural and racial circumstances of the United States; questions of fairness in the distribution of kidney dialysis.
James Childress, "Who Shall Live When Not All Can Live?" **Soundings** 53 (Winter 1970): 339-355.
Jeffrey Prottas, **et al.**, "Cross-National Differences in Dialysis Rates," **Health Care Financing Review** 4 (March 1983): 91-103.

18. Transplantation
Visit by transplant nephrologist (kidney transplant team) from University of Pennsylvania Hospital, who will speak on "What scientific developments make

kidney transplant possible?". If there is a particular technology which is critical, the nephrologist will be asked to explain it.

James D. Hardy, **et al.**, **Hardy's Textbook of Surgery** (New York: Lippincott Medical, 1983), pp. 198-213.

19. Hour Exam II

20. The Physician and Technology

Impact of technology on the way in which the physician practices medicine with special attention to the "malpractice crisis."

Harvey W. Freishtat, "Technology versus Regulation: Which is the Lower Cost Alternative?," in Barbara J. McNeil and Ernest G. Cravalho, eds., **Central Issues in Medical Technology** (Boston: Auburn House, 1982), pp. 175-183.

Louise Lander, **Defective Medicine** (New York: Farrar, Strauss, and Giroux, 1978), pp. 34-56, 131-142.

21. The Impact of Technology Upon Medical Care: An Overview

David Mechanic, "The Growth of Medical Technology and Bureaucracy: Implications for Medical Care," in John B. McKinlay, ed., **Technology and the Future of Health Care** (Cambridge, Mass.: MIT Press, 1982), pp. 1-18.

Ernest M. Gruenberg, "The Failures of Success," in **ibid.**, pp. 19-40.

Office of Technology Assessment, **Medical Technology and Costs of the Medicare Program** (Washington, D.C.: U.S. Government Printing Office, 1984), pp. 43-61.

22. The Hospital as a Locus of Health Technology

How medical technology immediately impacts upon hospitals, especially in the area of cost.

Juddith L. Wagner and Michael Zubkoff, "Medical Technology and Hospital Costs," in McKinlay, **Technology and the Future of Health Care** (see 21, above), pp. 104-130.

23. Impact of Technologies Upon Patient Care in the Hospital

Attention to the way in which technologies actually become distributed in hospitals, with attention to outcomes for patients.

Louise B. Russell, **Technology in Hospitals: Medical Advances and Their Diffusion** (Washington, D.C.: Brookings, 1979), pp. 99-131.

Alan M. Garber, **et al.**, "Case Mix, Costs and Outcomes," **New England Journal of Medicine** 310 (May 10, 1984): 1231-1237.

24. How Do Technologies Develop in Medicine?

Purpose of this class is to give the student some idea of the process of technology development in health care. The lecture will be devoted to detailing the procedure that must be followed in order to receive approval for experimentation. If time permits, there will be attention to the question of the cost of this regulatory procedure.

John B. McKinlay, "From 'Promising Report' to 'Standard Procedure': Seven Stages in the Career of a Medical Innovation," in McKinlay, **Technology and the Future of Health Care** (see 21, above), pp. 233-270.

W. Vickery Stoughton, "Medical Costs and Technology Regulation: The Pivotal Role of Hospitals," in McNeil and Cravalho, **Central Issues in Medical Technology** (see 20, above), pp. 37-50.

25. Is Medicine a Science?
    Samuel Gorovitz and Alasdair MacIntyre, "Toward a Theory of Medical Fallibility," **The Hastings Center Report** 5 (Dec. 1975): 13-23.

26. Controlling Medical Technology: Technology Assessment and Cost Containment. Hospitals as Decision Makers.
    What is it that hospitals owe their patients; how do these obligations to provide care impact upon the use of technology in the hospital?
    D. Mark Hahler, **et al.**, "Ethical Issues in Informed Consent: Research on Medical Cost Containment," **Journal of the American Medical Association** 247 (Jan. 22, 1982): 481-485.
    LeRoy Walters, "Technology Assessment," **Encyclopedia of Bioethics** (New York: Free Press, 1978), v. 4, pp. 1650-1654.
    Edmund Pellegrino, "Hospitals as Moral Agents," in Pellegrino, **Humanism and the Physician** (Knoxville: University of Tennessee Press, 1979), pp. 141-151.

27. Discussion of Doctor/Patient Relationship. Deciding What to Do, Pt. I
    Limitations on our powers to choose what we should do, including our own history and our societal consensus on what process is due to a person who might be denied a scarce good which they need.
    Guido Calabresi and Phillip Bobbitt, **Tragic Choices** (New York: W. W. Norton, 1978), pp. 149-191.

28. Discussion of Doctor/Patient Relationship. Deciding What to Do, Pt. II
    Focus on the conditions of our culture which make it difficult to get agreement upon most matters of substance. What we do with medical technology is one more example of a broader cultural condition.
    Alasdair MacIntyre, **After Virtue** (Notre Dame, Ind.: University of Notre Dame Press, 1983).

29. Final Examination

EXAMPLES OF STUDY QUESTIONS

The following questions should be used to test your understanding of the reading assignment for the designated class. If you cannot answer the questions before class, make sure that you can after the lecture/discussion.

Class 3. X-ray Imaging

1. State two reasons why the detail or resolution of x-ray computed tomography (CT) pictures is not as fine as that of conventional x-ray pictures?
2. What are the principal advantages of computed tomography (CT) over conventional x-ray radiography?
3. What is the specific role of the computer in CT imaging?
4. The variation in contrast in an x-ray picture is due to the variation of what property of the different types of tissue?
5. A dose of 5 sieverts of x-radiation is usually lethal. How many ergs of energy are deposited in a gram of tissue exposed to this does of radiation?
6. Why is one sievert of radiation in the form of charged particles such as electrons or alpha particles more damaging to DNA molecules than a sievert of x-rays?

7. Radiation from natural sources is continually passing through our bodies, usually with no discernible harmful effects. How is this possible?
8. Distinguish between high transfer and low transfer forms of radiation. What is being transferred?
9. Of the various man-made sources of radiation exposure, which is most serious?
10. A dose of two sieverts of x-rays absorbed in less than a second is more damaging to chromosomes than the same does absorbed over several days. Why is this? The dose rate is not as important for high transfer radiation. Explain.

Class 5: Ultrasonics

1. Ultrasonic waves of frequency 4.00 MHz have a wavelength of 0.385mm in soft tissue. What is the speed of sound in this tissue?
2. Ultrasonic waves propagate through soft biologic tissue at a speed of 1540m/s. What is the maximum repetition rate of short bursts of diagnostic sound waves, if one pulse is transmitted through the abdomen, reflected, and recorded by the receiver before the next pulse is sent? Assume that a typical abdomen is 30 cm in thickness and the system needs 0.001 second to recover between pulses.
3. Which ultrasonic wave will produce an image with higher axial resolution, a 9 MHz or a 3 MHz wave? Justify your answer.

Class 5: Positron Emission Tomography (PET)

1. Why does the positron travel such a short distance before the gamma rays are produced?
2. Why does the distance traveled by the positron before the gamma pair is created lower the resolution of the image?
3. Why are the two gamma rays emitted very nearly 180° apart, i.e., in almost exactly opposite directions?
4. Why do all the gamma rays received by PET scan detectors have nearly the same energy?
5. The positrons emitted by the radioactive isotopes in the body have very low energy and yet the detected gamma rays have energies of over 500,000 electron volts. Where does the gamma ray energy come from?
6. The rest energy of an electron is 511,000 electron volts. What is the energy of the gamma rays detected in a PET scan? Explain.

Class 6: Magnetic Resonance Imaging, I

1. Which nucleus precesses at a higher rotational frequency in a constant magnetic field, hydrogen or phosphorous? Explain.
2. The magnetic moment of the nucleus, i.e., its intrinsic magnetic field, makes it act like a compass needle and experience a force tending to twist it into the direction of an external magnetic field. However, instead of snapping into line the nucleus precesses like a top or gyroscope. What property of the nucleus prevents it from simply acting like a compass needle? Explain.
3. Protons (hydrogen nuclei) when placed in a magnetic field, precess about the field direction with one of two possible orientations. The magnetic moment of the nucleus is either generally parallel or generally antiparallel to the field. The parallel orientation is favored energetically since the magnetic moments try to line up with the field, and yet the number of spins in the parallel orientation exceeds the number that are generally antiparallel by only a small fraction. Explain. What is tending to mix up the spin orientations so as to make the two numbers almost exactly equal?

Class 7: Magnetic Resonance Imaging, II

1. Why must the MRI radio frequency magnetic field B, be perpendicular to the large constant field B_o?
2. What is the energy of one quantum (photon) of rf radiation delivered by an MRI rf coil? The energy required to ionize a hydrogen atom is 2.2×10^{-18} Joules. What is the significance of the relative sizes of these two energies?
3. What is the wavelength of electromagnetic radiation with just sufficient energy to ionize hydrogen?
4. a. What is the nuclear magnetic resonance frequency for protons in a magnetic field of 1.5 Tesla?
   b. How many times do the proton spins precess around the 1.5T field during a 90-degree pulse lasting 20×10^{-6} seconds?
   c. What is the strength B_1 of the rf field which produces this 90^o pulse?

Class 8: Magnetic Resonance Imaging III

1. The large constant magnetic field in a whole-body MRI magnet is produced along the axis of the cylindrical cavity in which the body lies. Why is it easier and cheaper to make the magnet this way? Show, with a sketch, how the coils are positioned to produce this field B_o.
2. Show how the rf coils are placed on an MRI magnet.
3. Briefly explain one way in which spatial encoding is done in MRI, i.e., how a characteristic property of the tissue at a particular point in the patient's body produces a certain shade of gray at a corresponding point on the image.

Class 13: Kidney Function

1. What were the two technological problems that had to be solved before the first practical artificial kidney could be developed in 1945?
2. What properties must a membrane have to be useful in dialysing blood?
3. Why is it that dialysed patients often feel no better right after treatment? A couple of days later they usually feel better, although by that time their blood is showing signs of uremia again. Explain.
4. What are some of the complications that ensue, if the rate of removal of potassium ions from the blood in dialysis is not properly controlled?

Reiser and Thomas Readings

1. Thomas speaks of the "old art" of medicine. What does he mean by this term? How does the introduction of technology mentioned in Rieser change this art? What are the costs and the benefits of the loss of this art?
2. How has diagnosis changed from the events described by Thomas to the situation of today?
3. How do patients contribute to the problems with the use of technology in medicine according to Reiser? What other patient demands are in direct contradiction to the ones for more technology? How is this so?
4. How do medical technologies lead both to an increase in power for the physicians and at the same time a loss in self-confidence?
5. Reiser argues that all data have to be interpreted. What does this mean and what importance does it have for medicine?
6. What is the distinction between precision and accuracy? What are the factors that influence precision in diagnosis? What are their relative importances historically?

HOURLY EXAM 1

Do all questions below. You will have 75 minutes. You may do the questions in any order. Please begin each question at the top of a page in the examination book.

1. List the advantages and disadvantages of computed tomography scanning as compared with X-ray imaging. (10%)

2. Reiser makes a point of the changes that have come about as a result of the introduction of technology into medical care. What is his perspective on this issue? Illustrate where appropriate with examples from Reiser and Thomas. If you can, give examples from the technologies we have studied. (40%)

3. The Technicare Magnetic Resonance Imaging (MRI) scanner that we visited operated with a magnetic field of 0.6 Tesla. What is the frequency of the rf pulses used to produce images at that facility? (5%)

4. A Magnetic Resonance Imaging (RRI) scanner produces images that show contrasting shades of gray for tissues that differ in their proton spin-spin relaxation time T_2. Explain how this is done. Your discussion should demonstrate an understanding of the rotating reference frame, the appropriate rf pulse sequence, and the response of the magnetic spins to these pulses. (30%)

5. Is the frequency of a 90° pulse greater than, less than, or the same as that of a 180° pulse? Explain. (5%)

6. In the picture of a color television set, electrons are given energies of 25,000 volts. If an electron with 25,000 electron volts of energy were to give all of this energy to a quantum of electromagnetic radiation:
   a) what would be the frequency of the radiation?
   b) what would be the wavelength of the radiation?
   c) would this radiation have sufficient energy to damage DNA in human tissue? Explain. (10%)

$h = 6.62 \times 10^{-34}$ Joule seconds

$c = 3.0 \times 10^{8}$ m/s

γ protons $= 2.68 \times 10^{8}$ seconds^{-1} Tesla^{-1}

1 electron volt $= 1.6 \times 10^{-19}$ Joule

HOURLY EXAM 2

1. Cyclosporine may not be on the tip of the tongue of the general population, even when mixed with cranberry juice, but it is much on the minds of people suffering from end state renal disease (ESRD). Yet immunologists find it difficult to control, according to Dr. Grossman. What are the advantages and disadvantages of using cyclosporine? (10%)

2. A close friend your age has just learned that she is suffering from acute kidney failure. She has been told that she will either require hemodialysis in a center, continuous ambulatory peritoneal dialysis (CAPD), or a transplant. How would you explain the advantages and disadvantages of each therapy to her? (35%)

3. Compare and contrast the way in which the normal kidney excretes water and waste products with the function of a hemodialysis machine. (15%)

4. There were several early attempts to do hemodialysis, but satisfactory long-term dialysis could not be performed until three breakthroughs were made: one scientific, one technological, and one clinical. Explain. (10%)

5. Why is potassium such a critical ion to control in dialysis? (5%)

6. During dialysis, water is extracted from a patient's blood, but various ions may be added to the blood. How can molecules and ions go in opposite directions at the same time? (5%)

7. You are on the staff of Congressperson Jones of the twenty-seventh district of New Lafayette. There is legislation pending to fund hemophilia treatment in New Lafayette so that the hemophilia program would work in the same manner as the present ESRD program (end stage renal disease program) works in both the United States and New Lafayette. What questions would you insist should be asked and answered before Congressperson Jones decides how to vote on this bill? Why? Assume for purposes of the question that New Lafayette has 220 million citizens and that there are 10,000 hemophiliacs. Also assume that the drug for treating hemophilia costs $100,000 per patient per year. Finally, assume that New Lafayette has the same racial composition and average income as the United States. (20%)

FINAL EXAMINATION

1. In **Defective Medicine** Louise Lander quotes a lawyer as follows: "In this age of consumerism, even the most knowledgeable and thorough doctor is compelled to practice defensively." What does it mean to practice medicine defensively? Referring to the specific medical technologies we have studied and the health care professionals who have spoken to us during this course, how might any of these people, if they chose to, practice defensive medicine? (15%)

2. Mahler, Veatch, and Sidel give four models of the patient-physician relationship: the engineering model, the priestly model, the collegial model, and the contractual model. Describe each of the four health care professionals that we met this semester in terms of these models. Justify your analysis. Are there other models which might better describe any of these people? What might these models be? (For your memory, we met a transplant nephrologist, a dialysis supervisor, a radiologist, and a MRI site manager). (30%)

3. MacKinlay describes seven stages in the career of a technological innovation. Demonstrate your understanding of MacKinlay's analysis by associating a specific medical technology with each of at least four of the seven stages and explain why it fits there. (The emphasis here is upon your understanding of MacKinlay rather than upon the accuracy of your assessment of the technologies.) (20%)
   Given what MacKinlay says, what are the problems in attempting to control technology in medicine? (15%)

4. What is the relationship between hospitals and technological development? What factors would lead a hospital to buy a new technology? What factors would inhibit a hospital in buying a new technology? (20%)

SECTION II: TECHNOLOGY IN THE CONTEMPORARY WORLD

Part 3: Themes in Technology Studies

TECHNOLOGY AND CONTEMPORARY POLITICS AND SOCIETY

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INTRODUCTION

The course "Technology and Contemporary Politics and Society" is taught as an elective available to student's in Kutztown University's Masters in Public Administration program. The course is also open to undergraduate seniors who meet certain requirements. Therefore, the course is primarily intended for public administration and political science students, although occasionally graduate students from the College of Education use courses in the MPA curriculum to fulfill their elective requirements.

The course is intended to provide an opportunity for individuals who are interested in public administration, or the political system in general, to explore the ways in which some major technologies impact on our society and the political system. Many of the questions related to technologies such as microelectronics or recombinant DNA are questions that raise important issues of public policy: questions related to the granting of patents, government regulation, environmental protection, or the development of weapons systems. The course is designed to acquaint you with some of the particulars of various technologies and to examine some of the public policy issues that develop out of the application of these technologies.

Political scientists and students of Public Administration frequently focus on organizations, structures, and behaviors within the political system. Courses on political process, organizational structure, and personnel practices are standard offerings. However, attempts to explore factors exogenous to the political system, and the effects of those factors on the political system, are less frequent. This course will help students of public administration develop an understanding which will enable them to deal with the public policy questions produced by technological change and also help them to become cognizant of the technological forces that are shaping and changing the political system around them.

To accomplish these goals, the course involves students in readings, lectures, and discussions. This material deals mainly with recent and contemporary events. In addition, the film series **Connections** (available from Penn State University and PBS) is used to provide a visual medium, to give the student a sense of the historic tides of technological change, and a sense of the impact of those innovations on various sectors of society.

REQUIRED TEXTS

Alvin Toffler, **The Third Wave** (New York: Bantam, 1980).
H. Dominic Covvey and N.H. McAlister, **Computer Consciousness: Surviving the Automated 80s** (Reading, Mass.: Addison-Wesley, 1980).
Albert Teich, **Technology and Man's Future**, 3rd ed., (New York: St. Martin's Press, 1981).

Clifford Grobstein, **A Double Image of the Double Helix** (San Francisco: W. H. Freeman, 1979).

National Academy of Sciences, **Science and Technology: A Five-Year Outlook** (San Francisco: W. H. Freeman, 1979).

ADDITIONAL READING MATERIALS

Throughout the course there will be additional reading materials. These materials will be available on library reserve at the circulation desk. Also, there will be some materials handed out in class.

SUPPLEMENTARY FILM SERIES

Although the course work will consist mainly of reading, lecture, class discussions, and presentations, the members of the class will be required to attend showings of the PBS film series **Connections: An Alternative View of Change**. This film series examines the impact of the introduction of various technologies on society and historical change. The film series provides supplementary material to the course texts and also some historical perspective. The films will serve as the basis for further discussion.

COURSE DESCRIPTION

We live in a world of rapid social and political change. Much of that change is spurred by technological innovation. The introduction of computers has had an impact on almost all aspects of our lives. The extent of computer diffusion in our society has led to widespread calls for computer literacy in the educational system. The development of nuclear weapons and intercontinental ballistic missiles has changed strategic thinking and our view of the fragility of the world. Telecommunications and satellites have drastically altered the nature of diplomacy and the images countries have of each other. Recombinant DNA technologies pose fundamental questions about man's control of evolution and, at the very least, raise significant legal and public policy issues. Of course this incomplete list could be expanded, but the fact that technology is important to today's politics is widely recognized.

This course is designed to introduce students to some of the technologies that are changing their lives and will continue to change their lives in the future. (The course is not focused on developing knowledge of the intricacies of the technologies **per se**, but rather on the effects of those technologies.) The course will examine two major technologies that are having a revolutionary impact on politics and society: computers/micro-electronics and recombinant DNA. These two technologies have been identified by numerous scholars as technologies that will alter many societal relationships and political structures.

The course will also provide students with some theoretical perspectives on the relationship between technology and social and political change. This second aspect of the course is as important as that dealing with the technologies themselves. It is necessary to provide students with the skills with which they can analyze change around them and to place that political change in a scholarly perspective. Theoretical frameworks enable one to attempt the analysis of wholes rather than reacting to discrete events.

A third element of the course will be to develop the students' awareness of the role of technology assessment in today's political arena. Historically, new technologies have been introduced into the economy and society as they were developed. Little analysis was done on the effects that these technologies would have on society or the ecology. Today the subject of technology assessment is of great concern to many scholars and government officials. In the course, students will examine some techniques of technology assessment and deal with questions such as when should a decision be made not to implement a technology.

Throughout the course the instructor and students will be dealing not only with description and analysis, but also with important value questions and public policy issues. The time to make policy decisions on many of the issues addressed in the course is now or in the immediate future. Therefore, policy assessment and evaluation with value assumptions made clear is an important element in understanding technology and contemporary politics and society.

COURSE OBJECTIVES

Some of the capabilities developed by the course are listed below. After successfully completing the course, the student should be able to:

1. Identify and define various concepts and terms related to computers and recombinant DNA.
2. Demonstrate an understanding of the political impacts of computers, microprocessors, and recombinant DNA research.
3. Specify public policy issues relating to these technologies.
4. Apply theoretical perspectives in the analysis of political change.
5. Apply basic techniques of policy analysis and technology assessment to contemporary issues.

GRADING AND OTHER POLICIES

1. Evaluation of a student's performance in the course and the assignment of a course grade will be based on: 1) a mid-term exam, 2) participation and presentation in class, 3) a final exam, and 4) a term paper. Each component will be weighted approximately as follows:

Mid-term exam	25%
Classroom	15%
Final exam.	30%
Term paper.	30%

2. No make-up examinations will be given except for a valid medical excuse. Any make-up examinations that are given will be unique for each individual.

3. The student bears the responsibility for class attendance. While no formal roll is taken, those who miss class will be responsible for ALL material discussed and all course work assigned.

4. As a general policy no incompletes (I) will be given in place of a grade. Any assignments that require the submission of work done outside of class must be turned in on the date specified at the class period.

COURSE OUTLINE

Week 1: I. Perspectives on Technology and Political and Social Change
- A. Theories of Social Change
- B. Theories of Political Change and Development
- C. Technology as a Force of Political Change

Reading assignments, Section I (Perspectives)

Toffler, **The Third Wave**, emphasis on ch. 4, pp. 46-60; ch. 19, pp. 244-264; ch. 22, pp. 311-327; ch. 23, pp. 328-348; ch. 27, pp. 392-415; ch. 28, pp. 416-443.
Teich, **Technology and Man's Future**, Part I, pp. 1-163.
National Acad. of Sciences, **Science and Technology**, pp. 1-5.
Robert H. Lauer, **Perspectives on Social Change** (Boston: Allyn and Bacon, 1977), pp. 1-21.

Weeks 2, 3: II. Computers and Microelectronics--Background
- A. Historical Development of Computers
- B. Principles of Computer Functions
- C. Computers in Our Society

Reading assignments, Section II (Computers--Background)

Covvey and McAlister, **Computer Consciousness**.
National Acad. of Sciences, **Science and Technology**, Part II, pp. 215-340, with emphasis on ch. 4, pp. 215-251.
Molly Gleiser, "Men and Machines Before Babbage," **Datamation** 24 (Oct. 1978): 125-130.
Molly Gleiser, "The Loom of Lyons," **Datamation** 25 (Sept. 1979): 216-226.
Nancy Stern, "In the Beginning the ENIAC," **Datamation** 25 (May 1979): 229-234.

Weeks 4, 5: III. Computer Related Issues in Politics and Public Policy
- A. Domestic Politics
  1. single issue politics
  2. organization of work (electronic cottage, robotics)
  3. national security and cryptography
  4. privacy
  5. government operations

Reading assignments, Section III. A. (Computers and Public Policy--Domestic Politics)

Ted Becker, "Teledemocracy," **The Futurist** 15 (Dec. 1981): 6-9.
Dan T. Moore, "Will Robots Save Democracy?" **The Futurist** 15 (Aug. 1981): 14-19.
Hollis Vail, "The Home Computer Terminal: Transforming the Household of Tomorrow," **The Futurist** 14 (Dec. 1980): 52-58.
Amy Wohl, "A Review of Office Automation," **Datamation** 26 (Feb. 1980): 116-119.
Tom McCusker, "Examining the Office of the Future," **Datamation** 26 (Feb. 1980): 120-121.

Weeks 6, 7: III. Computer Related Issues in Politics and Public Policy (cont.)
- B. International Politics

1. information revolution and telecommunications
2. technology transfer
3. weapons development
4. transborder data flow

Reading Assignments Section III. B. (Computers and Public Policy--International Politics)

James Dator, "Beyond the Nation State: Three Images of Global Governance," **The Futurist** 15 (Dec. 1981): 24.

Newt and Marianne Gingrich, "Post-Industrial Politics," **The Futurist** 15 (Dec. 1981): 29-32.

Edward Cornish, "The Coming of an Information Society," **The Futurist** 15 (April 1981): 14-21.

Graham T. Molitor, "The Information Society: The Path to Post-Industrial Growth," **The Futurist** 15 (April 1981): 23-30.

Weeks 8, 9: IV. Genetic Technology--Background

A. History and Development of Recombinant DNA
B. Overview of Genetic Technology
C. Early Attempts at Regulating Genetic Technology

Reading Assignments Section IV (Genetic Technology--Background)

Clifford Grobstein, **A Double Image of the Double Helix.**

Weeks 10, 11: V. Genetic Technology Related Issues in Politics and Public Policy

A. Domestic Policies
1. government regulation
2. patents on life forms
3. creation of new industries
4. genetic screening
5. genetics and occupational health and safety

Reading Assignments, Section V. A. (Genetic Technology and Public Policy--Domestic Politics)

National Acad. of Sciences, **Science and Technology**, Part I, ch. 2 and 3, pp. 59-211.

Scientific American 245 (Sept. 1981): special issue on biotechnology.

Steven J. Hochhauser, "Bringing Biotechnology to Market," **High Technology** 3 (Feb. 1983): 55-60.

Weeks 12, 13: V. Genetic Technology Related Issues in Politics and Public Policy (cont.)

B. International Politics
1. The Green Revolution II
2. weapons development
3. ecological impact
4. a genetic underclass?

Reading Assignments, Section V. B. (Genetic Technology and Public Policy--International Politics)

Jonathan B. Tucker, "Biochips: Can Molecules Compute?" **High Technology** 4 (Feb. 1984): 36-47.

Donald Louria, "Monstrous Microbes: The Danger of Genetic Engineering," **The Futurist** 15 (Oct. 1981): 17-22.
"The Organic Computer," **Discover** 3 (May 1982): 76-79.
John V. Granger, **Technology and International Relations** (San Francisco: Freeman, 1979), ch. 3, pp. 30-47.

Weeks 14, 15: VI. Technology Assessment
A. Technology Assessment in Historical Perspective
B. Methods of Technology Assessment
C. Case Studies in Technology Assessment and Public Policy
D. Technology, Political and Social Change, and Public Policy Choice

Reading Assignments, Section VI (Technology Assessment)
Teich, **Technology and Man's Future**, Parts 2 and 3, pp. 164-418.
National Acad. of Sciences, **Science and Technology**, Part III and IV, pp. 343-516.

SUGGESTED ADDITIONAL READING

Armstrong, Joe E. **Strategies for Conducting Technology Assessments** (Boulder, Colo.: Westview Press, 1980).
Ayres, Robert, and Steven M. Miller. **Robotics: Applications and Social Implications** (New York: Ballinger, 1983).
Boorstin, Daniel J. **The Republic of Technology** (New York: Harper and Row, 1978).
Cherfas, Jeremy. **Man-Made Life: An Overview of the Science, Technology and Commerce of Genetic Engineering** (New York: Pantheon, 1983).
Feigenbaum, Edward, and Pamela McCorduck. **The Fifth Generation: Artificial Intelligence and Japan's Computer Challenge to the World** (Reading, Mass.: Addison-Wesley, 1983).
Forester, Tom, ed. **The Microelectronics Revolution: The Complete Guide to the New Technology and Its Impact on Society** (Cambridge, Mass.: MIT Press, 1981).
Friedrichs, Gunter, and Adam Schaff, eds. **Microelectronics and Society: For Better or for Worse** (New York: Pergamon, 1982).
Granger, John V. **Technology and International Relations** (San Francisco: W. H. Freeman, 1979).
Hanson, Early D., ed. **Recombinant DNA Research and the Human Prospect** (Washington: American Chemical Society, 1983).
Harzany, Zsolt, and Richard Hutton. **Genetic Prophecy: Beyond the Double Helix** (New York: Rawson, Wade, 1981).
Hyde, Margaret. **Computers That Think? The Search for Artificial Intelligence** (New York: Enslow, 1982).
Kidder, Tracy. **The Soul of a New Machine** (Boston: Little, Brown, 1981).
Lambright, W. Henry. **Governing Science and Technology** (New York: Oxford University Press, 1976)
Lauer, Robert. **Perspectives on Social Change** (Boston: Allyn and Bacon, 1977).
Laver, Murray. **Computers and Social Change** (Cambridge: Cambridge University Press, 1980).
Martin, James. **Telematic Society: A Challenge for Tomorrow** (Englewood Cliffs: Prentice-Hall, 1981).
Martino, Joseph P. **Technological Forecasting for Decision Making** (New York: Elsevier, 1983).
McCorduck, Pamela. **Machines Who Think: A Personal Inquiry into the History and Prospects of Artificial Intelligence** (San Francisco: W. H. Freeman, 1979).

Nagel, Stuart S. **Policy Evaluation: Making Optimum Decisions** (New York: Praeger, 1982).
Naisbitt, John. **Megatrends: Ten New Directions Transforming Our Lives** (New York: Warner Books, 1982).
Porter, Alan L., and Frederick Rossini. **A Guidebook for Technology Assessment and Impact Analysis** (New York: Elsevier, 1979).
Rifkin, Jeremy. **Algeny** (New York: Viking Press, 1983).
Rosenthal, Albert, ed. **Public Science Policy and Administration** (Alburquerque: University of New Mexico Press, 1973).
U.S. Congress, Office of Technology Assessment. **Automation and the Workplace: Selected Labor, Education and Training Issues** (Washington: USGPO, 1983).

NUCLEAR PROLIFERATION: TECHNOLOGY AND POLITICS

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PREREQUISITES

One year of a physical science; one year of political science, history, or economics; junior or senior standing; or permission of instructor.

DESCRIPTION

The development of nuclear weapons by nations that do not now possess them and the potential impact of nuclear proliferation on the U.S. is usually overshadowed by discussions of the control of strategic nuclear weapons and East-West defense and arms control policies. Less attention is given to the proliferation issue, and relatively few Americans are aware of U.S. government policies that have evolved to deal with it. Yet policies to prevent the "horizontal" proliferation of nuclear weapons are currently assigned a high priority by the U.S. and the U.S.S.R. Proliferation policy is one of the few national security areas where both nations have a common interest in cooperation.

We will explore the following questions:

* What is the current U.S. policy on proliferation?
* How is U.S. non-proliferation policy formulated and implemented?
* What are the technologies that play a prominent part in the proliferation of nuclear weapons?
* What is the connection between civilian nuclear energy and nuclear weapons proliferation?
* What choices might be made in the selection of nuclear reactor technologies for development and export that might affect nuclear proliferation potential?
* What should the policy of the U.S. be for trade, foreign aid, and defense assistance to countries whose proliferation potential is high?
* How do we assess the potential of other nations to develop nuclear weapons?
* Which federal agencies are involved in the formulation and implementation of U.S. proliferation policy?
* How does nuclear proliferation policy affect other arms control and national security decisions?
* What are the military, social, and economic consequences of nuclear weapons development for potential proliferators in the Third World?
* How effective are international agency efforts to control proliferation?
* Might the basic assumptions of the Non-Proliferation Treaty be Wrong? Might more "equitable" distribution of nuclear weapons provide greater international stability by reducing superpower intervention in the Third World?

You will have an opportunity to explore these issues using materials from various sources such as the Congressional Research Service, Department of State, Central

Intelligence Agency, Office of Technology Assessment, International Atomic Energy Agency, and the United Nations.

After an introduction to the technology, you will have an opportunity to conduct an inquiry into an area of international affairs where opinions differ. You will be expected to develop your own position on a number of issues. This is not a course where you can obtain all the information you need from the Instructor. We will begin with the fundamentals of the subject and gradually move into an exploration of policy issues.

If security restrictions permit us to do so, we will visit Brookhaven National Laboratory to see an operating research reactor and meet members of a research group that performs contract work on proliferation and safeguard problems for the U.S. Department of State.

You will have an opportunity to become familiar with computer data retrieval methods that can expedite the preparation of papers and summaries. You will construct your own data base of material derived from sources as diverse as the **New York Times**, **Wall Street Journal**, **Washington Post**, **Pravda**, and the **Times of India**.

Students satisfying course requirements will acquire the general knowledge needed to work on proliferation issues as entry-level interns at federal agencies.

PRIMARY TEXTS

Anthony Nero, **Guidebook to Nuclear Reactors** (Berkeley: University of California Press, 1984).
Leonard Spector, **New Nuclear Nations** (New York: Vintage Books, 1985).
Stephen Meyer, **The Dynamics of Nuclear Proliferation** (Chicago: University of Chicago Press, 1985).

RESERVE BOOKS

The following books have been placed on reserve in the main library for you use.

Arkin, William. **Nuclear Battlefields** (Cambridge, Mass.: Ballinger Publ. Co., 1985).
Arkin, William. **Research Guide to Current Military Affairs** (Washington, D.C.: Institute for Policy Studies, 1982).
Barnaby, Frank, **et al.**, eds. **Internationalization to Prevent the Spread of Nuclear Weapons** (London: Taylor and Francis, 1980).
Chayes, Abram. **International Arrangements for Fuel Reprocessing** (Cambridge, Mass.: Ballinger Publ. Co, 1977).
Cochran, Thomas, **et al.** **Nuclear Weapons Data Book** (Cambridge, Mass.: Ballinger Publ. Co., 1984).
Dunn, Lewis. **Controlling the Bomb** (New Haven, Conn.: Yale University Press, 1982).
Goldblatt, Jozef. **Safeguarding the Atom** (London: Taylor and Francis, 1985).
Goldblatt, Jozef. **Non-Proliferation: The Why and Wherefore** (London: Taylor and Francis, 1985).
Greenwood, Ted. **Nuclear Power and Weapons Proliferation** (London: International Institute for Strategic Studies, 1976).
Herken, Gregg. **Counsels of War** (New York: Knopf, 1984).
Herken, Gregg. **The Winning Weapon** (New York: Knopf, 1980).

Kincade, William. **Nuclear Proliferation in the 80s** (New York: St. Martin's Press, 1982).
Krass, Allan, **et al.** **Uranium Enrichment and Nuclear Weapons Proliferation** (London: Taylor and Francis, 1983).
Myrdal, Alva. **The Game of Disarmament** (New York: Pantheon Books, 1976).
Pilat, Joseph. **The Non-Proliferation Predicament** (New Brunswick, N.J.: Transaction Books, 1985).
Rotblat, Joseph, ed. **Scientists, the Arms Race and Disarmament** (London: Taylor and Francis, 1982).
Snyder, Jed. **Limiting Nuclear Proliferation** (Cambridge, Mass.: Ballinger, 1985).
Tsipis, Kosta. **Arsenal** (New York: Simon and Schuster, 1983).
Weissman, Steve. **The Islamic Bomb** (New York: New York Times Books, 1981).
Willrich, Mason, and Theodore B. Taylor. **Nuclear Theft: Risks and Safeguards** (Cambridge, Mass.: Ballinger, 1974).
Winner, Langdon. **Autonomous Technology** (Cambridge, Mass.: MIT Press, 1977).
Wohlstetter, Albert, **et al.** **Swords from Plowshares: The Military Potential of Civilian Nuclear Energy** (Chicago: University of Chicago Press, 1977).

COURSE REQUIREMENTS

1. Participation in class including at least one oral report.
2. Bi-Weekly assignments requiring short (two typewritten pages) papers [indicated in Course Outline below].
3. Development of a bibliography on a special topic related to proliferation. This bibliography is due after the second week of the course. Topics will be assigned during the first and second class meetings.
4. Preparation of a review paper that summarizes the literature on the assigned special topic and develops policy recommendations on behalf of the agency or office assigned to you. Your outline will be reviewed with the Instructor, who will meet individually with you as your paper develops.

This course emphasizes individual and small group research to develop the necessary concepts and information. Discussions will be organized to simulate the policy debates that take place in the key U.S. agencies and congressional groups concerned with proliferation policy. You will be asked to write to the agency group assigned to you to seek information about current policy bearing on proliferation-related issues. Some agencies will be less forthcoming than others because security restrictions and time constraints may limit their ability to respond. Our goal is to make you at least somewhat familiar with offices and people that develop recommendations and implement U.S. proliferation policy. To the extent that it is possible for you to obtain a reasonable understanding of the agency's interests from your correspondence and reading, you can attempt to develop policy recommendations in your term paper that would be of interest to agency staff. Class sessions will be used to give you the opportunity to make presentations and ask questions. You will learn to use the specialized resources of the reference library and the U.S. Government Document collection.

COURSE OUTLINE

Week 1-2: NUCLEAR WEAPONS
- A. Principles and Design
- B. Manufacture

C. Stockpiles and Controls
D. Current World Distribution

Bi-Weekly Assignment

* Explain the source of the energy that is released in the explosion of a fission weapon. Your explanation should cover the following: structure of the nucleus; neutrons and protons; binding energy; critical mass; fission; fissile materials; isotopes; yield; kiloton; chain reaction.

* Discuss the design (include diagrams) of fission weapons, including both "gun" and implosion types. Explain how critical masses are obtained in each design. What were the major design problems that had to be overcome in each case? Your response should explain the function of each of the following: initiator; explosive lenses; timing circuits; arming and fusing devices. Give estimates for the yields of typical weapons.

Week 3-4: INTRODUCTION TO NUCLEAR FUEL CYCLES

A. Uranium Enrichment Technology
B. Nuclear Reactor Principles and Design
C. Reprocessing Technology

Bi-Weekly Assignment

* Review the history of the U.S. "Manhattan District Project." What were the functions of the major units? Who were the scientific leaders? The military leaders? Comment on the political relationships among the leadership groups. Develop a time-line for the project. What was the Franck Committee and what did it recommend? In retrospect, was the Committee correct? Explain your view.

* Describe and explain the "front end" of the nuclear fuel cycle beginning with the mining of uranium and culminating in the production of weapons grade fissile material. Use diagrams and briefly explain what is taking place at each step.

Week 5-6: SOURCES OF NUCLEAR WEAPONS MATERIALS

A. Diversion from Civilian Power Reactors
B. Dedicated Facilities
C. Purchase, Theft, and Terrorism

Bi-Weekly Assignment

* List major world uranium suppliers, and find out what you can about relationships between the suppliers and the following countries: Brazil, Argentina, Pakistan, India, Israel, Iraq, Iran, North and South Korea, South Africa, Libya. (Note that some of these countries may be suppliers.) Think up some way of describing these relationships in graphic form.

* Explain how a nuclear reactor (LWR) operates, outlining the functions of the following: core, moderator, control rods, core cooling, containment vessel.

Week 7-8. POLITICAL INCENTIVES AND DISINCENTIVES FOR PROLIFERATION

A. Deterrence
B. National Status
C. Domestic Politics
D. Strategic Autonomy

Bi-Weekly Assignment

* Explain how plutonium is produced in a power nuclear reactor as a by-product of normal operations; and how it would be produced in a reactor specifically designed for this purpose (such reactors are known as "production reactors"). In your paper, you should explain what "reprocessing" is, and how it completes the fuel cycle. Which nations now are involved in the reprocessing of spent fuel from power reactors? What is the nature of the "spent fuel problem?"

* Describe the key provisions of the Nuclear Non-Proliferation Treaty. What, exactly, is the treaty designed to do? How are treaty provisions monitored? What are the treaty's strengths and weaknesses? Who are the prominent non-signatories? What is a typical rationale for not signing?

Week 9-10. CONTROL OF PROLIFERATION

A. The Non-Proliferation Treaty and International Atomic Energy Agency
B. Safeguard Technology and Verification Methods
C. Federal Agency and Congressional Oversight
D. Comparison of Carter and Reagan Administration Policies

Bi-Weekly Assignment

* What are the key provisions and status of the following treaties? (Limited Test Ban Treaty; Threshold Test Ban Treaty; Peaceful Nuclear Explosion Treaty)

* What are the principal objections of the Reagan administration to a comprehensive test ban treaty (CTB)? How is CTB related to NPT, particularly in the views of non-weapons signatories? How are those views countered by persons opposed to CTB?

* Outline the way in which agencies of the federal government are organized to deal with proliferation responsibilities. In brief, who does what? Use an organizational chart diagram.

Week 11-12. ROUTES TO NUCLEAR WEAPONS

A. Significance of National Technological Capability
B. Availability of Facilities
C. Availability of Resources
D. Influence of Political Relationships
E. Perceptions of Controls

Bi-Weekly Assignment

* Explain several of the problems associated with efforts by the U.S. to limit the transfer of nuclear technologies to states that have not signed the NPT.

* Outline the organization and functions of the International Atomic Energy Agency (IAEA). In your response, describe what is meant by "nuclear safeguards," and give examples of ways in which they are applied. What are the possible implications of IAEA procedures for other arms control verification efforts?

Week 13-14. THE INTERNATIONAL NUCLEAR INDUSTRY

A. Real and Perceived Need for Nuclear Energy
B. Development of Proliferation-Prone Facilities
C. Relations Between Suppliers

Bi-Weekly Assignment

* What are the implications of advances is isotopic enrichment processes for U.S. efforts to limit proliferation by controlling the export of relevant technology?

* Assess the potential threat posed by terrorists to existing stocks of fissile materials and nuclear weapons. What are the most sensitive and exposed points in the U.S. system? What measures have been taken to protect these points from terrorist activity? What else might be done in the future?

Week 15. ANALYSES OF PROLIFERATION POTENTIAL

A. Middle East
B. Africa
C. North Asia
D. South America
E. South Asia

APPENDIX I: BIBLIOGRAPHY SEARCH HEADINGS

*uranium supply (mining, refining, export-import)
*uranium enrichment (gaseous diffusion, centrifuge, laser)

*reprocessing of spent reactor fuel	*breeder reactors
*nuclear reactors, links to nuclear weapons	*nuclear reactors, production
*nuclear weapons design	*nuclear weapons manufacturing
*nuclear weapons storage	*nuclear weapons transport
*nuclear weapons stockpiles	*nuclear weapons, terrorist threat
*nuclear safeguards	*non-proliferation treaty
*International Atomic Energy Agency	*verification of NPT agreements
*non-proliferation and congressional committees	*London Nuclear Suppliers' Group
*Nuclear Non-Proliferation Act of 1978	*nuclear export controls
*energy demand, U.S.	*energy demand, world

*Convention of Physical Protection of Nuclear Materials

*Limited Test Ban Treaty	*Atomic Energy Act, U.S. 1954
*nuclear fuel cycle, internationalization of	*Comprehensive Test Ban Treaty
*NPT review conferences	*Tlatelolco, Treaty of

*_____ (and nuclear weapons) [list below]

South Africa	Pakistan	India	Iraq
Sweden	Iran	Israel	Egypt
China	North Korea	South Korea	Argentina
Brazil	Taiwan	Libya	

APPENDIX II: FEDERAL ORGANIZATIONS FOR FORMULATION AND IMPLEMENTATION OF NON-PROLIFERATION POLICY

You will have an opportunity to select one of the agencies listed below in connection with your term paper research. Write to the office to request resource materials and related policy information. If you succeed in becoming familiar with the work and policies of the agency, you can try to orient your term paper in a way that reflects the agency's interest. Try to develop a set of policy recommendations that might be of interest to agency staff. We may also try to arrange visits to Washington for discussions with staff members.

Complete addresses and the names of current officials working in these offices can be found in a number of directories in the Government Document Reference Room in the main library.

Department of Commerce
- Undersecretary for International Trade Administration
  - Assistant Secretary for Trade Administration
    - Deputy Assistant Secretary for Export Administration
      - Head, Office of Export Licensing
      - Head, Office of Technology and Policy Analysis
  - Assistant Secretary for Trade Development
    - Head, Interagency Task Force for Nuclear Exports

Department of Defense
- Undersecretary for Policy
  - Assistant Secretary for International Security Policy
    - Deputy Assistant Secretary, Negotiations Policy
      - Non-proliferation Policy Directorate
  - National Security Agency

Department of Energy
- Assistant Secretary, International Affairs and Energy Emergencies
  - Deputy Assistant Secretary for International Affairs
    - Office of Non-Proliferation Policy
- Assistant Secretary, Nuclear Energy
  - Director, Program Support
    - International Programs Division
- Assistant Secretary, Defense Programs
  - Deputy Assistant Secretary for Security Affairs
    - Office of International Security Affairs
    - Office of Safeguards and Security
  - Deputy Assistant Secretary for Intelligence
    - Office of Scientific and Technological Intelligence
      - Technological Intelligence Division
        - Non-Proliferation Group
    - Special Projects ("Z") Division-Lawrence Livermore Lab.
      - *International Assessments *Emergency Response

Department of State
- Ambassador at Large for Non-Proliferation Policy
- Asst. Secretary for Oceans and International Environmental & Scientific Affairs
  - Deputy Assistant Secretary for Nuclear Energy and Energy Technology
    - Office of Nuclear Export Control
    - Office of Nuclear Technology and Safeguards
    - Office of Non-Proliferation and Export Policy

Bureau of Intelligence and Research
Deputy Assistant Secretary of State, Regional Analysis
Deputy Assistant Secretary of State, Functional Analysis and Research
Strategic Forces
Nuclear and Scientific Division

Office of Legal Adviser
Deputy Legal Adviser
Assistant Legal Adviser for Nuclear Affairs

Bureau of International Organizational Affairs
Office of Science and Technology
U.S. Mission at International Organizations in Vienna

Arms Control and Disarmament Agency
Bureau of Nuclear Weapons and Control
International Nuclear Affairs Division
Nuclear Safeguards and Technology Division

Central Intelligence Agency
Office of Global Issues
Nuclear Proliferation Branch
Office of Strategic and Weapons Research
Nuclear Proliferation Branch
Regional Offices

Export-Import Bank
(No specific office for nuclear export financing. Teams are formed on a case-by-case basis with an engineer, loan officer, economist, and a lawyer.)

Nuclear Regulatory Commission
Office of International Program
Office of Nuclear Materials and Safeguards

Interagency Groups
Subgroup on Nuclear Export Coordination (SNEC)
(State, Energy, Defense, Commerce, ACDA, and NRC)

Interagency Task Force on Nuclear Exports
(Commerce, Energy, State, Treasury, U.S. Trade Representative, Export-Import Bank, Overseas Private Investment Corporation, and observers from NRC and USIA)

National Intelligence Council
(Composed of National Intelligence Officers with either regional or functional responsibility)

Senate
Foreign Relations Committee

Governmental Affairs Committee
Subcommittee on Energy, Nuclear Proliferation, and Government Processes

House of Representatives

- Foreign Affairs Committee
  - Subcommittee on Arms Control, International Security, and Science
  - Subcommittee on International Economic Policy and Trade
  - Regional Subcommittees (Africa, Asian and Pacific Affairs, Europe and the Middle East, Western Hemisphere Affairs)
- Committee on Energy and Commerce
  - Subcommittee on Energy Conservation and Power

Congressional Support Agencies

- General Accounting Office
- Office of Technology Assessment
- Congressional Research Service

TECHNOLOGY, THE ENVIRONMENT, AND HUMAN VALUES

Stephen H. Cutcliffe
Technology Studies Resource Center and STS Program
Lehigh University
Bethlehem, Pennsylvania

INTRODUCTION

For more than 200 years, U.S. industrial growth has been based not only on technological development but on the availability of initially abundant resources and fuels and a seemingly boundless and endlessly absorbent environment. We have increasingly come to realize that unfettered economic expansion and population growth carries with it certain environmental costs. Decisions of trade-off between environmental preservation, economic well-being, human health, and so on inevitably involve value choices. The nature and source of our values and attitudes regarding technology and the environment will be the focus of both group discussions and individualized research projects and reports in this seminar.

Initially we will identify a range of environmental values and attitudes toward nature and analyze how they relate to other human values, including our attitudes regarding technological development. Subsequently we will trace the historical development of these attitudes and values and the ways in which they have been actualized through individual action and governmental policy. In the end each student will hopefully have reached not only a general understanding of the issues at stake but also have clarified his or her own personal position regarding the environment. We will pursue this understanding through assigned readings, discussion, selected films, an "environmental folder," and an individual research project and oral report presented by each student.

TEXTS

There are three major texts for the course:

Ian Barbour, **Technology, Environment, and Human Values** (New York: Praeger, 1980). [from which the course title is drawn]
Kristin Shrader-Frechette, **Environmental Ethics** (Pacific Grove, Calif.: Boxwood Press, 1981).
Roderick Nash, **Wilderness and the American Mind**, 3rd ed., (New Haven, Conn.: Yale University Press, 1982).

All three are available in the bookstore. Specific reading assignments are indicated in the class schedule.

COURSE REQUIREMENTS

Because this is not a lecture course, but rather a seminar, all members will be expected not only to read the assignments, but to come to class prepared to discuss the readings and issues at hand. Since a major portion of the final grade will be based on class participation, I will not look lightly upon repeated absences or a failure to join in discussion of the readings, films, etc.

Students will maintain an "environmental folder" of newspaper clippings, reaction papers, observations, etc. pertaining to the subject matter of the course. The intent of the folder is to heighten student awareness of environmental questions and issues and to help formulate an informed position or point of view regarding those issues. Clippings and observations will frequently provide material for classroom discussions. Folders will be reviewed by the instructor at two different times during the course of the semester (class meeting 11 and class meeting 22).

In addition to the readings and class discussion, each student will be required to prepare a 10-12 page term paper on a topic to be chosen in consultation with the instructor. The topic may be either historical or contemporary in nature and may focus on an individual, a specific event or controversy, or an environmental theme relevant to the course. The paper should be more than a mere description or narrative of the topic chosen. In addition, the paper should explicate the values held by the individual(s) and group(s) involved in a given event. The paper should focus on a topic not extensively covered in class discussion but should draw upon class discussions and readings regarding the associated values. Paper topics must be cleared with the instructor no later than the 11th class meeting. A brief, 2-page written statement of initial findings and a tentative bibliography are due on the instructor's office on the day of the 22nd class meeting. There will be no regular classes on the 23rd and 24th class sessions to provide extra time for students to research their papers. However, individual meetings with the instructor to discuss the progress on each student's paper are required. A brief oral presentation of 15-20 minutes will be made by each student during the final four class meetings of the semester. The final typed draft of the paper is due to later than Noon ten days after the last regular class session.

The make-up of the final grade will be as follows:

Class Participation	25%
Folder	10
Mid-Term	25
Oral Presentation and Outline	10
Paper	30

COURSE OUTLINE
[This semester-long course meets bi-weekly, Editor]

PART I -- ATTITUDES AND VALUES

1. Introduction to Course
   Film: **Koyaanisqatsi**, from Pacific Arts Video Mail Order, P.O. Box 22770, Carmel, CA 93922 [in 1/2" VHS or BETA formats for $59.95 plus $4.95 handling].

2. The Need for an Environmental Ethic
   One page reaction paper on **Koyaanisqatsi** for folder and class discussion
   Read: Barbour, **Technology, Environment**, ch. 1, pp. 1-9, and
   Shrader-Frechette, **Environmental Ethics**, ch. 1, pp. 3-27.

3. Attitudes Toward Nature and Technology
   Read: Barbour, **Technology, Environment**, ch. 2-3, pp. 13-58, and
   Shrader-Frechette, **Environmental Ethics**, ch. 2, pp. 28-56.

4. Human Values
   Read: Barbour, **Technology, Environment**, ch. 4, pp. 59-80, and
   Shrader-Frechette, **Environmental Ethics**, ch. 9, pp. 221-236.

5. The Environment and Human Benefits
   Read: Barbour, **Technology, Environment**, pp. 81-84, 91-97, and
   Shrader-Frechette, **Environmental Ethics**, ch. 6, pp. 127-153.

6. Duties to Future Generations
   Read: Barbour, **Technology, Environment**, pp. 84-88, and
   Shrader-Frechette, **Environmental Ethics**, ch. 3, pp. 59-81.

7. Rights of Animals and Natural Objects
   Read: Barbour, **Technology, Environment**, pp. 88-91, and
   Shrader-Frechette, **Environmental Ethics**, ch. 4-5, pp. 82-126.

PART II -- HISTORICAL DEVELOPMENT OF ENVIRONMENTALISM AND WILDERNESS PRESERVATION

8. Colonial and Early National Attitudes
   Read: Nash, **Wilderness**, ch. 1-4, pp. 1-83.

9. The Early Conservation Movement
   Read: Nash, **Wilderness**, ch. 5-8, pp. 84-140.

10. The Twentieth Century: Conservation Comes of Age
    Read: Nash, **Wilderness**, ch. 9-12, pp. 140-237.

11. Contemporary Wilderness Issues
    Read: Nash, **Wilderness**, ch. 13-15 and epilogue, pp. 238-341 and 379-388.
    Paper Topics Due
    Environmental Folder Due

PART III -- ENVIRONMENTAL POLICIES AND PROBLEMS

12. Political Process
    Film: **The Regulators: Our Invisible Government** [analyzes how EPA puts into reality (law) one aspect of the 1977 Clean Air Act Amendment], 16mm, color, 50m, Learning Corporation of America, 1350 Avenue of the Americas, New York, NY 10019, sale $750, rental $75.
    Read: Barbour, **Technology, Environment**, ch. 6, pp. 109-135.

13. Cost/Benefit Analysis and Technology Assessment
    Guest Speaker: Mr. Richard Pastor, U.S. Environmental Protection Agency.
    Read: Barbour, **Technology, Environment**, ch. 8-9, pp. 163-208.

14. Library Class on Term-Paper Sources.
    Take-home mid-term due

15. The Environment and the Economy
    Read: Barbour, **Technology, Environment**, ch. 12, pp. 274-293, and
    Shrader-Frechette, **Environmental Ethics**, ch. 8, pp. 196-220.

16. Pollution and Land Use
    Film: **Requiem or Recovery**, 16mm, color, 25m, 1981, National Film Board of Canada, available from the Acid Rain Foundation, 1630 Blackhawk Hills, St. Paul, MN 55122, for $25 rental.
    Read: Barbour, **Technology, Environment**, ch. 7, pp. 136-162.

17. Food and Pesticides
    Read: Barbour, **Technology, Environment**, ch. 11, pt. 1, pp. 245-253, and Shrader-Frechette, **Environmental Ethics**, ch. 11, pp. 270-324.

18. Population Growth
    Read: Barbour, **Technology, Environment**, ch. 11, pt. 2, pp. 254-262, and Shrader-Frechette, **Environmental Ethics**, ch. 10, pp. 239-269.

19. Resource Development
    Film: **Is Anybody Home on the Range?** [analyzes boom/bust phenomenon and associated values as Wyoming undergoes massive energy development], 16mm, color, 60m, c1983-84, available from New Front Programming Services, 1409 Willow St., Minneapolis, MN 55403, rental $90.
    Read: Barbour, **Technology, Environment**, ch. 10, pp. 211-244.

20. Resource Development, cont. (Nuclear Energy)
    Read: Shrader-Frechette, **Environmental Ethics**, ch. 12, pp. 325-347.

21. Appropriate Technology and Alternative Lifestyles
    Film: **The Other Way** [about E.F. Schumacher and appropriate technology], 16mm, color, 26m, n.d. [c1975]
    Read: Barbour, **Technology, Environment**, ch. 13, pp. 294-319, and Shrader-Frechette, **Environmental Ethics**, ch. 7, pp. 154-193.

PART IV -- TERM PROJECTS

22. Preliminary bibliography and two-page statement of findings to date and direction of paper due. Environmental Folders Due.

23-24. Individual appointments with instructor to go over preliminary bibliography and findings

25-28. Oral Presentations and Final Outlines Due

SELECTED LIST OF SAMPLE RESEARCH TOPICS

*John Perkins Marsh
*Wallace Stegner
*Ansel Adams
*James Watt
*William Clark
*Wendell Berry
*Minnesota powerline controversy
*King's Canyon
*SST
*Storm King Mountain
*TMI
*Cross Florida Canal
*Diablo Canyon Nuclear Plant
*ground water use
*toxic waste disposal
*acid rain
*fluoride
*oil spills
*whale hunting
*population growth
*food supply

TAKE HOME MID-TERM EXAMINATION

Answer both questions. Your essays should be carefully organized and well written. They should have a theme or point of view which is supported by evidence drawn from our readings and discussion. In other words, unsupported generalizations are unacceptable, as are essays cluttered with facts but lacking a coherent argument. Your essays need not be typewritten, but they must be legible.

I. Imagine the following scenario:

A 200-acre piece of land has recently been willed to a small Pennsylvania town with the proviso that the town board should "develop the land in a manner that is consistent with the long-term happiness and progress of the citizens of the community." The town board must now decide the eventual use of the land through a zoning decision. A number of groups of people representing different perspectives have an interest in the final decision regarding the use of this parcel of land. One group represents the local university, whose biology department is interested in the marshlands that take up nearly 70 percent of the acreage and that have been a nesting place and an informal recreation area for many years. Biologists have operated a small research laboratory on the land, with the owner's permission, for the last ten years. Most of their research centers on the food chain, and the department has been the recipient of numerous federal grants. This group argues, among other things, that an expansion of their research would bring more funding, more students and faculty, and, of course, more prestige to the community; that their work on the food chain would have a major impact on problems of world hunger; and that some portion of the marshlands might continue to be available for recreational purposes.

A second group consists of executives from a large corporation that manufactures laboratory and industrial instruments; the corporation also holds large defense department contracts. This company would use the land to construct a large subsidiary plant, and it must have all the land. Among the arguments from this group are: a) the facility would provide between 200 and 300 permanent jobs as well as perhaps 150 temporary construction jobs (because of a decline in traditional heavy industry, the unemployment rate in town, especially among the working class, is running at a percentage well above the national average), b) the firm is offering $250,000 to buy the land from the town, c) the taxes the company will have to pay will significantly reduce the individual tax burden, d) plans for further expansion in this community depend on a favorable decision.

Finally, there is a local homeowner's association, a group of 500 middle and upper-middle class families living in those areas surrounding the land in dispute. The association has been successful in various efforts to improve the quality of life in the community, particularly with regard to environmental conditions. It would like the town board to maintain the land essentially as it is, making only minor changes such as the installation of picnic areas on the high ground, and the building of an elevated walkway through a portion of the marsh. It is prepared to pay for such improvements, and it plans to call for a town referendum on the use of the land. The association argues that its past relationship with the deceased owner and his history of allowing public use of the area implies that this plan is consistent with the terms of his will, that the community has very little in the way of town parks or recreation areas, that there will be no cost to the

town, and that the present small facility used by the university biologists could remain.

Assume you are a member of the town board that must make the decision regarding the disposition of the land in question. In a 4-5 page essay articulate the reasoning process by which: 1) you would weigh each set of values against the others; and 2) justify your selection of one of the positions based on some combination of values that you believe will be in the best interests of the community.

II. Henry David Thoreau, John Muir, Aldo Leopold, and Howard Zahniser all played important roles in the development of American attitudes toward wilderness and in the formation of an organized movement for wilderness preservation in the United States. In the equivalent of 5-6 typewritten pages, briefly describe the role of each individual, analyze the values that underlay the position each held, and show how each either differed from and/or drew upon those that came before.

COMPUTERS AND THE INTELLECTUAL WORLD

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COURSE OBJECTIVES

The aim of this course is to provide a survey of what the educated person ought to know about computers. It is not a course in computer science, nor will it teach a student how to use a computer. Instead it will consider such topics as the following: the history of computers; the relation of logic and computers; the power of computers; the nature of artificial intelligence; the physical and theoretical limitations of machines; comparisons and contrasts between computing machines and the human brain with regard to feeling, consciousness, thinking, and intelligence; and the opportunities and dangers which computer technology provide to democratic institutions. No knowledge of computers is presupposed.

READINGS

A very substantial amount of reading will be required. The following is a complete list, although not every item will be read in its entirety.

Augarten, Stan. **Bit by Bit: An Illustrated History of Computers** (New York: Ticknor & Fields, 1984).

Bolter, J. David. **Turing's Man: Western Culture in the Computer Age** (Chapel Hill: University of North Carolina Press, 1984).

Bernstein, Jeremy. "Marvin Minsky," **The New Yorker** 57 (December 14, 1981): 50-126.

Burnham, David. **The Rise of the Computer State** (New York: Vintage, 1984).

DeLong, Howard. "Unsolved Problems in Arithmetic," **Scientific American** 224 (March 1971): 50-60.

Halmos, P. R. "The Legend of John von Neumann," **American Mathematical Monthly** 80 (April 1973): 382-394.

Hodges, Andrew. **Alan Turing: The Enigma** (New York: Simon and Schuster, 1983).

Hofstadter, Douglas R. **Godel, Escher, Bach: An Eternal Golden Braid** (New York: Basic Books, 1979).

Hofstadter, Douglas R., and Daniel C. Dennett, eds. **The Mind's I: Fantasies and Reflections on Self and Soul** (New York: Basic Books, 1981).

Hopcroft, John E. "Turing Machines," **Scientific American** 250 (May 1984): 86-98.

Schank, Roger C. [with Peter G. Childers]. **The Cognitive Computer: On Language, Learning, and Artificial Intelligence** (Reading, Mass.: Addison-Wesley, 1984).

Smith, Steven B. **The Great Mental Calculators: The Psychology, Methods, and Lives of Calculating Prodigies, Past and Present** (New York: Columbia University Press, 1983).

Turkle, Sherry. **The Second Self: Computers and the Human Spirit** (New York: Simon and Schuster, 1984).

REQUIREMENTS

There are three requirements for the course:

1. A mid-term exam. It will consist of two parts: Part I (3/5 of grade) will be a series of short answer questions on the lectures and the reading assignments in the first half of the course. Part II (2/5 of grade) will be an essay question on either Andrew Hodges' **Alan Turing: The Enigma** or Roger Schank's **The Cognitive Computer.**

2. A final exam. It will be similar to the earlier exam. Part I (3/5 of grade) will be a series of short answer question on the lectures and the reading assignments from mid-term on. Part II (2/5 of grade) will be an essay question on David Burnham's **The Rise of the Computer State.**

3. A final paper. The topic will be a comparison of Sherry Turkle's **The Second Self** with David Bolter's **Turing's Man.**

COURSE OUTLINES

The topics in this course tend to overlap, and isolating individual issues is difficult. Hence the divisions which follow are not to be taken very strictly.

PART I. THE HISTORY OF COMPUTERS

There exists no entirely adequate history of computers. The reason, I believe, is the great complexity of the task. Few have attempted it. Herman Goldstine's **The Computer from Pascal to von Neumann** (Princeton, N.J.: Princeton University Press, 1980) is interesting and in a number of ways quite good. However, topics are not well introduced and the emphasis is on those parts of the history of computers in which the author was personally involved. It is thus not a good introduction, but a book to be read after one knows something about the topic. Joel Shurkin's **Engines of the Mind** (New York: W. W. Norton, 1984) is less scholarly but more balanced. It is well written, and Shurkin does an excellent job in communicating the exciting story of the birth of computers. However, the book suffers from a lack of illustrations and diagrams, and it is technically incorrect at various places. We will use Stan Augarten's **Bit by Bit**, which is not quite as well written nor as detailed, but it contains superb illustrations, and these greatly improve the reader's appreciation of the various developments of the computer.

Class 1 No assignment.
Class 2 Augarten, **Bit by Bit**, preface, pp. 2-97.
Class 3 Augarten, **Bit by Bit**, pp. 98-165, 289-294, 166-193.
Class 4 Augarten, **Bit by Bit**, pp. 194-285.

PART II. PERSONALITIES

The purpose of this section is to round out Augarten's account by looking at some of the personalities who he does not adequately treat. We start with von Neumann. Halmos' account is short and impressionistic, but he has a better feel for this extraordinary genius than does Augarten. We then turn to Hodges' magnificent biography of Alan Turing. Both Augarten and Goldstine give Turing little space, but he was enormously important to the development of the computer. His was a life filled with stupendous intellectual achievement, military intrigue, and personal tragedy. Finally, we look at Jeremy Bernstein's engrossing profile of

Marvin Minsky, one of the central and most interesting figures in the AI (AI = artificial intelligence) community. Note: While doing the next two or three assignments you should decide whether you wish to write your exam essay on Hodges' **Alan Turing**. If so, finish the book. If not, you need read no further than page 159 and may write your exam essay on Roger Schank's **The Cognitive Computer**. Schank is one of the leading figures in AI, and his popular book will introduce some of the topics we will be taking up later in the course. The assignments are approximately equal in length and the choice is yours.

Class 5 Halmos, "Legend of John von Neumann," pp. 382-394.
Hodges, **Alan Turing**, pp. 1-45.
Class 6 Hodges, **Alan Turing**, pp. 46-110.
Class 7 Hodges, **Alan Turing**, pp. 111-159.
Class 8 Bernstein, "Marvin Minsky," pp. 50-126.

PART III. LOGIC AND MACHINES

Here we continue some of the themes already raised in Hodges' biography. The history of logic illustrates the rather natural way in which the study of certain logical questions raises the issue of computing machines and their limitations. The initial reading -- "Unsolved Problems in Arithmetic" -- explains how results in logic (often called the limitative theorems) put theoretical constraints on what either humans or machines can know or do. Hopcroft's article gives a good description of what Turing machines are, and how they relate to logic and computers. We then turn to Douglas Hofstadter's **Godel, Escher, Bach**. This book was on the best-seller list for many weeks, and it won the American Book Award and a Pulitzer Prize. We do not have time to read it all, but we will read enough to experience in some detail its verbal and intellectual pyrotechnics.

Class 9 DeLong, "Unsolved Problems in Arithmetic," pp. 50-60.
Hopcroft, "Turing Machines," pp. 86-98.
Class 10 Hofstadter, **Godel, Escher, Bach**, pp. 1-60.
Class 11 Hofstadter, **Godel, Escher, Bach**, pp. 61-126.
Class 12 EXAM.
Class 13 Hofstadter, **Godel, Escher, Bach**, pp. 127-180.
Class 14 Hofstadter, **Godel, Escher, Bach**, pp. 181-230.

[OPEN PERIOD: CLASSES 15 and 16. Burnham's **The Rise of the Computer State** and Turkle's **The Second Self** are required reading, respectively, for the second exam and the final paper. This is an excellent time to read one or both of these books.]

Class 17 Hofstadter, **Godel, Escher, Bach**, pp. 231-272.

PART IV. MINDS AND MACHINES

In order to compare minds and machines it is reasonable to look at a human being's ability to calculate. Multiply 365, 365, 365, 365, 365, 365 by itself in your head. This problem, which seems absolutely impossible to do, was actually done in about a minute by a ten-year old named Truman Henry Safford. In the first reading we will dip into Steven Smith's **The Great Mental Calculators**, a book which describes the incredible mental feats of calculating prodigies. Some of these prodigies are geniuses, and some are idiots. Smith believes that the capacity for language and the capacity for calculating virtuosity are rooted in the same facility, and that it is only an unfavorable environment which has prevented the vast majority of people from becoming "great mental calculators." He concludes that since calculating prodigies are Turing machines, so are all human beings. We

will examine this claim. Then we will turn to Hofstadter and Dennett's interesting collection of essays on cognitive science. It asks: What is a self or soul, and could anything but a human be correctly said to possess one? These essays lead one to see that these questions are deep and not easily answered.

Class 18 Smith, **The Great Mental Calculators**, pp. 3-6, 68-84, 178-180, 227-241.
Class 19 Hofstadter and Dennett, **The Mind's I**, pp. 53-95.
Class 20 Hofstadter and Dennett, **The Mind's I**, pp. 149-201.
Class 21 Hofstadter and Dennett, **The Mind's I**, pp. 100-115, 217-241.
Class 22 Hofstadter and Dennett, **The Mind's I**, pp. 269-283, 353-388.

PART V. COMPUTERS AND THE STATE

Computers in themselves are ethically neutral. They can be used to either support or undermine an ethically justifiable society. The reading for this section is David Burnham's **The Rise of the Computer State**. Its theme is the many and diverse ways in which computers have been, and can be, used to threaten democratic freedoms. This book will not be discussed in class. Instead it is required reading for the essay question on the exam. The topic of the essay will be the ways in which computers ought to be used to improve democratic institutions and the means which should be employed to guard against their misuse.

Class 23 EXAM.

PART VI. COMPUTERS AND THE HUMAN SPIRIT

Historians of language can often tell approximately where and when something was said by merely examining what was said and how. Historians of art often do something similar for works of art. Some historians of ideas think the same sort of thing holds in their subject. Thus J. David Bolter's **Turing's Man** claims each of us is a "Turing's Man," that is, each of us has been so influenced by the computer that, even if we never use one, the very way we think and the view we hold of ourselves is shaped to an important degree by those machines. We will critically examine this thesis. The paper due for the last class period will be a critical comparison of Bolter's views (which are primarily historical and cultural) with those of Turkle (which are primarily psychological and sociological). Turkle's book looks at the interesting question of how computers have influenced those who use them. Are hackers dehumanized by their love of computers? Do children by thinking computers are alive (as they often do) come to have a mechanical view of humanity? The paper will provide you with an opportunity to compare these two approaches to the world of computers.

Class 24 Bolter, **Turing's Man**, pp. 3-65.
Class 25 Bolter, **Turing's Man**, pp. 66-123.
Class 26 Bolter, **Turing's Man**, pp. 124-180.
Class 27 Bolter, **Turing's Man**, pp. 180-237.
Class 28 FINAL PAPER DUE.

SUGGESTED ADDITIONAL READINGS

If you liked Hofstadter's books you can hardly do better than to finish them. The same holds true for Smith's book.

Anderson, Alan Ross, ed. **Minds and Machines** (Englewood Cliffs, NJ: Prentice-Hall, 1964). An old collection, but it is still very worthwhile reading. It

contains J. R. Lucas's "Minds, Machines, and Godel," an essay which has produced more commentary than any other on the relation of logic and mind.

Feigenbaum, Edward A., and Pamela McCorduck. **The Fifth Generation: Artificial Intelligence and Japan's Computer Challenge to the World** (New York: New American Library, 1984). Two highly respected writers in the computer field claim that Japan will achieve a true Fifth Generation capability before the U.S., an event which will have enormous economic and social impact.

Gardner, Martin. **Logic Machines and Diagrams**, 2nd ed., (Chicago: University of Chicago Press, 1982). An interesting, readable, but highly selective account. I would especially recommend the last chapter entitled "Machine Intelligence."

Goldstine, Herman H. **The Computer from Pascal to von Neumann** (Princeton, NJ: Princeton University Press, 1980). Discussed above.

Hilts, Philip J. **Scientific Temperaments** (New York: Simon and Schuster, 1982). Includes a portrait of AI scientist John McCarthy. It would have been included in Part II of this course had time permitted.

Haugeland, John, ed. **Mind Design: Philosophy, Psychology, Artificial Intelligence** (Montgomery, Vermont: Bradford Books, 1981). A nice companion volume to Anderson's The essays are more technical than **The Mind's I**, but the course will put you in a very good position to read and enjoy them.

Kidder, Tracy. **The Soul of a New Machine** (New York: Avon, 1982). A Pulitzer Prize winning story of the creation of a new computer at Data General. It is interesting to compare this book with Augarten's account of the development of ENIAC.

McCulloch, Warren S. **Embodiments of Mind** (Cambridge, Mass.: MIT Press, 1965). McCulloch had some influence in the development of computers, especially in influencing others to consider the relation of the nervous system and the computer. The articles in this collection are in some ways out of date, but McCulloch had a genius for tantalizing writing. Consider merely the titles of some of the essays: "What is a Number, that a Man May Know It, and a Man, that He May Know a Number?", "Why the Mind is in the Head," "Where is Fancy Bred?", "What the Frog's Eye Tells the Frog's Brain," and "What's in the Brain that Ink May Character?"

Reid, T. R. **The Chip: The Microelectronics Revolution and the Men Who Made It** (New York: Simon and Schuster, 1985). An account by a journalist of the intense competition which led to the creation of the integrated circuit.

Rucker, Rudy. **Infinity and the Mind: The Science and Philosophy of the Infinite** (Boston: Birkhauser, 1982). Many of the topics discussed by Rucker are relevant to this course. Those who are interested in the relation of Godel's Incompleteness Theorem and the powers of men and machines will especially want to read Chapter Four: Robots and Souls.

Shurkin, Joel. **Engines of the Mind: A History of the Computer** (New York: W. W. Norton, 1984). Discussed above.

Torrance, Steve, ed. **The Mind and the Machine: Philosophical Aspects of Artificial Intelligence** (New York: John Wiley and Sons, 1984). An up-to-date series of articles. A sample of titles will indicate the flavor of the book. "The Structure of the Space of Possible Minds," "The Limits of AI: Thought Experiments and Conceptual Investigations," "What is it Like to be a Machine?" "Meta-level Inference and Consciousness," "Creativity in Man and Machines."

Weizenbaum, Joseph. **Computer Power and Human Reason** (San Francisco: W. H. Freeman, 1976). An MIT computer science professor claims that humans and computers are essentially different and that there are certain tasks computers should not do.

Yazdani, Masoud. **Artificial Intelligence: Human Effects** (New York: John Wiley, 1984). An interesting collection of articles on such topics as the relation of AI to medicine, law, education, psychology, and philosophy. For example,

A. Narayanan and D. Perrott ask "Can Computers have Legal Rights?" and the answer is in the affirmative. M.A. Boden states: "I believe a basically mechanistic view of the universe, and of human beings as creatures of it, to be true." However, she believes it is a "dangerous" truth since it tends "to encourage a dehumanization of our image of man, an undermining of our sense of responsibility and individuality." This tendency, she argues, is wrongheaded.

TELEVISION TECHNOLOGY AND SOCIAL IMPACT

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COURSE OBJECTIVES

The aim of this course is to explore the technology and social impact of a device that has become the hallmark of popular culture -- television. There are as many TV sets in America as there are people. The user-interface of television is so accommodating, however, that its technology is virtually invisible to the user. Although most Americans are intimately connected to a television set in their lives, the receiver itself is no more than the proverbial "black box."

In part because the production of images is a mystery to the audience, television commands unmatched credibility as a medium of communications. The overwhelming majority of Americas depend on television for entertainment and for information about local, national, and international affairs. Television is our window on the world. Most viewers do not know how reporters, cameramen, and producers manipulate the broadcast image and, possibly, the audience response.

COURSE REQUIREMENTS

In the beginning of the course, students will spend a week intensively watching prime time television and analyzing the content. The class will visit a television broadcasting studio and study how the image is produced, transmitted, received, and displayed. In the next segment of the course, we will discuss the effects of television on the audience, focusing on persuasion, attitude reinforcement, and resistance. As we read, we will consider relevant research issues. How can the effects of television be evaluated? Students will apply their answers to a social science experiment, involving the manipulation of television messages and the assessment of audience impact. For the purposes of the experiment, students will prepare video tapes using a camera and video recording and editing equipment. The class will observe the subjects' response, and analyze the results with the help of a computer. No prior experience with psychology, statistics, or computers is required (although any of those would be helpful). Individual students will contribute to a group research paper and report on their findings in class.

Because the hands-on assignments of the course are time-consuming, other course requirements have been reduced accordingly. The following books are available for purchase at the College Bookstore:

George Comstock, **Television in America** (Beverly Hills, Calif.: Sage, 1980).

John Truxall, **Cybernetics** (Notes for EST 320, State University of New York at Stony Brook), ch. 7-8, pp. 7-1 to 7-67 and 8-1 to 8-87.

Additional readings on data entry, statistics, and statistical programs will be made available.

Every effort has been made to allow sufficient time for the completion of assigned work. Should you encounter an obstacle--mechanical, technical, or personal--please let me know immediately so that I can make adjustments. The course projects are interrelated, and the work of the whole class depends on each student's completing her work on time. Since lateness would seriously impair the progress of everyone else, late work will not be accepted.

COURSE OUTLINE
[This semester-length course meets once a week, Editor]

Week 1: Introduction: Television in American Life

Television observation assignments will be made in class. Students will work in pairs. Observation must be made on the assigned evening of the selected week on an assigned channel from 8:00 p.m. to 11:00 p.m. A record of observations of each program will be due in Week 3's class.

Week 2: Television Content: What's on the Tube?

Intensive observation of television content during a week of prime time. Record of observations due next class period. Short paper analyzing program content based on a review of all of the class observations for the week (3-5 pages) will be due class period no. 5.

Reading: George Comstock, **Television in America**, ch. 1 and 4, pp. 11-27 and 71-96.
Rex Moorfoot, **Television in the 'Eighties** (London: British Broadcasting Corporation, 1982), ch. 1, pp. 12-33.

Week 3: The Audience for Television

Who watches what? How do people "use" television? What functions does television serve for individuals? families? society? What is television's social potential? What is television's impact on children?

Completed observation records due in class.

Reading: Comstock, **Television in America**, ch. 2 and 5, pp. 29-41 and 97-122.
Horace Newcomb, ed., **Television: The Critical View** (New York: Oxford University Press, 1982), pt. 1, "The Fonz . . .," pp. 77-88, and "Texas: A Giant State of Mind," pp. 167-174.

Week 4: Making Television: The Technology of the Broadcast Image

Visiting Lecturer: Michael Isnardi, Advanced Television Research Group, MIT. How does a video camera work? How does the television receiver operate? How is television broadcast? How is color grafted onto a black-and-white television?

Paper (3-5 pages) based on CLASS observations due.

Reading: John Truxall, **Cybernetics**, selection from ch. 4-6.

Week 5: Research on Television

What is the television research agenda?
Discussion of research topics: formulating a hypothesis and pilot experiment. Organization of research groups. Each group will meet to discuss the plan of research and assign individual tasks. The research design is due in class next class period.

Reading: Comstock, **Television in America**, ch. 3 and 6, pp. 43-70, 123-148.

Morris Jonowitz and Paul Hirsch, **Reader in Public Opinion and Mass Communication** (New York: The Free Press, 1981), "Repetitive Advertising and the Consumer," pp. 409-422.

Week 6: Producing and Editing a Videotape

Demonstration of video recording and editing equipment. Use of the video camera. Demonstrations of virtuoso editing: "Zelig"

Each group's videotape is DUE in the 8th week's class period.

Group research design (3 pages, including individual assignments) due.

Reading: Jonowitz and Hirsch, **Reader**, "Television News and Political Advertising," pp. 389-402.

Jarol B. Manheim and Richard C. Rich, **Empirical Political Analysis Research Methods in Political Science**, 2nd ed., (New York: Longman, 1986), ch. 5, pp. 68-84 ("Working from a Plan").

Week 7: No Class

Week 8: Producing a Questionnaire for the Experimental Design

What do we have to know about research subjects? What do we want subjects to tell us? Effective question wording. Preparing a questionnaire for data entry.

Experimental videotape and description (3 pp.) due.

Reading: Oliver Benson, **Political Science Laboratory** (Columbus, Ohio: Charles Merrill Publ. Col, 1969), ch. 6, pp. 198-234.

Sidney Kraus, ed., **The Great Debates** (Bloomington: Indiana University Press, 1962), ch. 11, pp. 173-223 ("The Debates in the Light of Research").

Week 9: Introduction to Statistics

How can we measure change or difference? Is there an association among our experimental variables? How much confidence can we have in our results? Groups will meet with instructor to plan administration of the experiment and agree on bibliography for group project.

Experimental questionnaire due.

Reading: Kenneth Bailey, **Methods of Social Research** (New York: Free Press, 1978), pp. 334-337, 341-347, 350-351.

Week 10: Administering an Audience Effects Experiment

Groups are responsible for organizing and administering the experiment, and coding the results for data entry during this week.

Week 11: Data Entry and Introduction to Statistics

Data entry and use of the computer. Demonstration of data entry and statistical analysis program in class.

Reading: Mingche M. Li, **Ysat User's Manual** (Lincoln, Mass.: Ming Telecomputing, Inc., 1986).

Susan W. Gray, **No Frills Statistics: A Guide for the First Year Student** (Totowa, N.J.: Rowman and Allanhold, 1984), ch. 9, pp. 104-119 ("Two Samples Z and T Tests").

Week 12: Visit to Advanced Television Research Project Facilities

Data listing and relevant statistics due.

Reading: Each group will read relevant articles on research topic.

Week 13: Group Conference with Instructor

Week 14: Group Presentations in Class
Each group will make an oral presentation of its project and results.
ALL GROUPS PROJECTS ARE DUE. LATE WORK WILL NOT BE ACCEPTED.

APPENDIX I

QUESTIONNAIRE USED TO ORGANIZE RESEARCH GROUPS AND EXPOSE CLASS TO QUANTITATIVE ANALYSIS

TELEVISION TECHNOLOGY AND SOCIAL IMPACT QUESTIONNAIRE

Name_____ Year_____
Dorm_____ Phone_____
Computer skills (check all that apply): __LOGIN __LOGOUT
__games __Emacs __SPSS
__statistical program (specify) _____
__programming language (specify) _____
__computer consultant __hacker __use own PC
Current or completed quantitative methods courses (specify)_____
_____
Film or photography skills (describe)_____
_____
Media internships or experience _____
_____
Ability to operate (check all that apply)
__video cassette recorder (type) _____
__video camera __video dubbing equipment
__audio dubbing equipment __car __van
I have ready access to the following during the semester (check all that apply)
__b&w TV __color TV __VCR __video camera __car __PC
Check all that describe you: __I prefer to be a leader.
__I am an accurate typist. __I am an idea person.
__I am a good organizer. __I am thorough and conscientious.
I like working with: __machines __people __numbers __computers.

About how many hours a week of television did you watch when you were in grade school? ___ hrs/wk in high school? ___ hrs/wk
during the college semester? ___ hrs/wk
Did your parents have rules about television when you were a child?
__No __Yes (describe and specify relevant age)_____
_____
My favorite shows are: _____
_____
__no favorite show __rarely or never watch TV
My favorite network news is on: (Check one)
__ABC __CBS __NBC __CNN __Don't care __Never Watch
Parents' or guardians' occupations (describe)_____
_____
Number of hours per week parents watch TV_____

As a parent, would you regulate amount/kind of TV your children watch? Why or why not? _____

_____

_____

_____

_____

Can you identify a favorite television commercial? If so describe what makes it a "good" commercial. _____

_____

_____

APPENDIX II
RESULTS FROM STUDENT QUESTIONNAIRE ON TELEVISION VIEWING

Did parents have rules about television viewing?

	Frequency	%
Code: 0 = No	15	50
1 = Yes or Yes, regarding viewing time	8	27
1.5 = Yes, regarding times & types of shows	3	10
2 = Yes, type of show	3	10
blanks = missing data	1	3
	30	100

Mean Score = .638

Would student regulate own children's TV viewing?

Code: 0 = No	6	20
0.5 = Some	2	7
1 = Yes or yes, time	11	37
1.5 = Yes time and type	3	10
2 = yes, type	7	23
blanks = missing data	1	3
	30	100

Mean score = 1.052

Average number of hours of television watched per week in

grade school	= 14.133	minimum = 0	maximum = 42
high school	= 12.283	minimum = 0	maximum = 42
college	= 3.433	minimum = 0	maximum = 16

APPENDIX III
ASSIGNMENT USED TO SET UP RESEARCH GROUPS FOR FINAL PROJECT

The last segment of the course involves the design and implementation of an audience effects experiment. The class will be divided into research groups so that each student has an opportunity to use the video recording and editing equipment and to participate in the data analysis. It is hoped that groups will offer mutual support in the research process.

Given severe resource constraints, students are encouraged to design a simple experiment that can be carried out in only a few weeks. The only requirement of the research design is that the experimental condition feature a segment of video

tape produced by the research group. We will spend some class time critiquing each design in detail. Since most students have designed an experiment prior to this occasion there should be no embarrassment in giving or taking suggestions. Both those whose work is under discussion and those who offer suggestions are involved in the learning process. Our aim is to improve the sturdiness and efficiency of the research designs.

The groups will carry out some phases of the experiments during class time, but the whole process will require considerable time outside of class. Data from the experiments will be entered into computer files and analyzed with a statistical program. Each group will present its research design, video tape, and findings to the class as a whole.

Below are some suggested audience impact experiments. Two were executed by student research groups in previous years, the others are new:

(1) Is an audience more likely to recall the content of a political ad embedded in a group of product commercials, or an ad surrounded by other political ads (a situation particularly prevalent towards the end of a campaign session)?

(2) Are advertising breaks more likely to permit absorption of information in news programs or more likely to clutter or confuse recall of news items?

(3) Are female voice-overs more or less convincing than male voice-overs in political or product ads, if the audience is female? male?

(4) Are individuals more likely to have longterm recall of a candidate debate if the debate is followed by a discussion than a debate without discussion?

(5) To what extent does the expression on the face of the anchorperson convey information about items in the news? Can an audience judge whether the anchorperson is favorable or unfavorable to a candidate from the anchorperson's facial expression during a story? Or, does the audience take its cues about the seriousness of a news item from the facial expression of the anchorperson?

(6) Is the audience more likely to remember the visual content of a video when the song is familiar or when it is new? Is the audience more likely to remember the lyrics of a song in video or audio alone?

TECHNOLOGY AND GENDER

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COURSE DESCRIPTION

In the study and practice of technology, the female is often omitted, and the question of gender all but ignored. Although women and men create, use, and are affected by technology, the male experience of technology--of weaponry, industry, computers--forms the usual, and largely unquestioned, frame of discourse and inquiry. There are important effects for our technological values and choices. This course will apply a gender analysis to the study of technology: for conceptual frameworks, for production and reproduction, for our environment, and for our future. The aim is to broaden the student's understanding of the critical issues, values, and choices that confront us in the technological age.

COURSE MATERIALS

The following materials, to be used in the course, are available for purchase at the campus bookstore:

Joan Rothschild, ed., **Machina Ex Dea: Feminist Perspectives on Technology** (New York and Oxford: Pergamon Press, 1983).

Martha Moore Trescott, ed., **Dynamos and Virgins Revisited: Women and Technological Change in History** (Metuchen, N.J.: Scarecrow Press, 1979).

Rita Arditti, Renate Duelli Klein, and Shelley Minden, eds., **Test-Tube Women: What Future for Motherhood?** (London and Boston: Pandora Press [Routledge & Kegan Paul], 1984).

In addition, a number of materials will be placed on library reserve and/or distributed in class, and films will be shown. Students are responsible for all assigned materials. Books listed in Section V (below) under each topic are strongly recommended for purchase by students selecting that topic for their papers.

EVALUATIONS/GRADING

Students' grades will be based on three written assignments, class presentations, and general level of interest and participation. The first assignment will be an examination on October 13th. The second assignment, a combined class presentation and paper, will be due between November 10th and December 8th, depending on when presented--see separate sheet at end of syllabus for details. The third assignment will be a final examination, due during Finals Period, date to be announced.

This course has been approved for Standard IV (Values) of the Core Curriculum. The course is also cross-listed for the Women's Studies Minor and the Technology, Society, and Values minor.

COURSE OUTLINE

I. WHY GENDER AND TECHNOLOGY? THE MEANING OF FEMINIST PERSPECTIVES [Sept. 8-15]

Joan Rothschild, "Introduction: Why **Machina Ex Dea**?," in Rothschild, pp. ix-xxix.

Joan Rothschild, "Turing's Man, Turing's Woman, or Turing's Person?: Gender, Language, and Computers," **Working Papers Series**, no. 166 (Spring 1986): Wellesley College Center for Research on Women.

Autumn Stanley, "Women Hold Up Two-Thirds of the Sky: Notes for a Revised History of Technology," in Rothschild, **Machina Ex Dea**, pp. 3-22.

Ruth Schwartz Cowan, "From Virginia Dare to Virginia Slims: Women and Technology in American Life," in Trescott, **Dynamos and Virgins**, pp. 30-44.

II. TECHNOLOGY, GENDER, AND PRODUCTION [Sept. 19-Oct. 6]

Overview

Joan Wallach Scott, "The Mechanization of Women's Work," **Scientific American** 247 (Sept. 1982): 167-187.

Roslyn Baxandall, Elizabeth Ewen, and Linda Gordon, "The Working Class Has Two Sexes," **Monthly Review** 28 (July-August 1976): 1-9.

Farm

Autumn Stanley, "Daughters of Isis, Daughters of Demeter: When Women Sowed and Reaped," **Women's Studies International Quarterly** 4, no. 3 (1981): 289-304.

Corlann G. Bush, "The Barn Is His, The House Is Mine: Agricultural Technology and Sex Roles," in George Daniels and Mark Rose, eds., **Energy and Transport** (Beverly Hills, Calif.: Sage, 1982), pp. 235-259.

Sally L. Hacker, "Farming Out the Home: Women and Agribusiness," **The Second Wave** 7 (Spring/Summer 1977): 38-48.

Factory

Susan Levine, "Ladies and Looms: The Social Impact of Machine Power in the American Carpet Industry," in Trescott, **Dynamos and Virgins**, pp. 67-76.

Judith A. McGaw, "Technological Change and Women's Work: Mechanization in the Berkshire Paper Industry, 1820-1855," in Trescott, **Dynamos and Virgins**, pp. 77-99.

Office

Margery Davies, "Woman's Place Is at the Typewriter: The Feminization of the Clerical Labor Force," **Radical America** 8 (July-August 1974): 225-261.

Household

Susan J. Kleinberg, "Technology and Women's Work: The Lives of Working Class Women in Pittsburgh, 1870-1900," in Trescott, **Dynamos and Virgins**, pp. 185-204.

Ruth Schwartz Cowan, "The 'Industrial Revolution' in the Home: Household Technology and Social Change in the 20th Century," in Trescott, **Dynamos and Virgins**, pp. 205-232.

Joan Rothschild, "Technology, Housework, and Women's Liberation: A Theoretical Analysis," in Rothschild, **Machina Ex Dea**, pp. 79-93.

First Examination

III. TECHNOLOGY, GENDER, AND REPRODUCTION [Oct. 17-27]

Deadline to select project for second assignment: Oct. 17

Barbara Katz Rothman, "The Meanings of Choice in Reproductive Technology," in Arditti, **Test-Tube Women**, pp. 23-33.

Ruth Hubbard, "Personal Courage Is Not Enough: Some Hazards of Childbearing in the 1980s," in **ibid.**, pp. 331-355.

Birth Prevention

Scarlet Pollock, "Refusing to Take Women Seriously: 'Side Effects' and the Politics of Contraception," in **ibid.**, pp. 138-152.

K. Kaufmann, "Abortion, a Woman's Matter: An Explanation of Who Controls Abortion and How and Why They Do It," in **ibid.**, pp. 213-234.

IV. GENDER DUALISM AND TECHNOLOGY [Oct. 31-Nov. 7]

Carolyn Merchant, "Mining the Earth's Womb," in Rothschild, **Machina Ex Dea**, pp. 99-117.

Shulamith Firestone, "The Dialectic within Cultural History," ch. 9 in **The Dialectic of Sex** (New York: Bantam, 1971) pp. 170-191.

Evelyn Fox Keller, "Women, Science and Popular Mythology," in Rothschild, **Machina Ex Dea**, pp. 130-146.

Elizabeth Fee, "Is Feminism a Threat to Scientific Objectivity?" **International Journal of Women's Studies** 4 (1981): 378-392.

V. GENDER AND TECHNOLOGY: CURRENT ISSUES [Nov. 10-Dec. 8]

Second Assignment: Class Presentations and Papers Due When Presented

Overview

Corlann Gee Bush, "Women and the Assessment of Technology: To Think, to Be; to Unthink, to Free," in Rothschild, **Machina Ex Dea**, pp. 151-170.

Reproduction [Nov. 10-14]

Jalna Hanmer, "Reproductive Technology: The Future for Women?," in Rothschild, **Machina Ex Dea**, pp. 183-197.

Robyn Rowland, "Reproductive Technologies: The Final Solution to the Woman Question?" in Arditti, **Test-Tube Women**, pp. 356-369.

plus 4-5 articles selected from the following:

Vimal Balasubrahmanyan, "Women as Targets in India's Family Planning Policy," in Arditti, **Test-Tube Women**, pp. 153-164.

Phillida Bunkle, "Calling the Shots? The International Politics of Depo-Provera," in **ibid.**, pp. 165-187.

Adele Clarke, "Subtle Forms of Sterilization Abuse: A Reproductive Rights Analysis," in **ibid.**, pp. 188-212.

Marsha Saxton, "Born and Unborn: The Implications of Reproductive Technologies for People with Disabilities," in **ibid.**, pp. 298-312.

Rayna Rapp, "XYLO: A True Story," in **ibid.**, pp. 313-328.

Betty Hoskins and Helen Bequaert Holmes, "Technology and Prenatal Femicide," in **ibid.**, pp. 237-255.

Viola Roggencamp, "Abortion of a Special Kind: Male Sex Selection in India," in **ibid.**, pp. 266-277.

"Test-Tube Babies and Clinics: Where Are They?" in **ibid.**, pp. 52-53.

Rebecca Albury, "Who Owns the Embryo? in Arditti, **ibid.**, pp. 54-67.

Jane Murphy, "From Mice to Men? Implications of Progress in Cloning Research," in **ibid.**, pp. 76-91.
Shelley Minden, "Designer Genes: A View from the Factory," in **ibid.**, pp. 92-98.
Susan Ince, "Inside the Surrogate Industry," in **ibid.**, pp. 99-116.
Francie Hornstein, "Children by Donor Insemination: A New Choice for Lesbians," in **ibid.**, pp. 373-381.
Carol Downer, "Through the Speculum" in **ibid.**, pp. 419-426.
Jalna Hanmer, "A Womb of One's Own," in **ibid.**, pp. 438-448.
Janice Raymond, "Feminist Ethics, Ecology and Vision," in **ibid.**, pp. 427-437.

Computers/Automation [Nov. 17-21]
Sally L. Hacker, "Sex Stratification, Technology and Organizational Change: A Longitudinal Case Study of AT&T," **Social Problems** 26 (June 1979): 539-557.
Roslyn Feldberg and Evelyn Glenn, "Technology and Work Degradation: Effects of Office Automation on Women Clerical Workers," in Rothschild, **Machina Ex Dea**, pp. 59-78.
Anne Machung, "Word Processing: Forward for Business, Backward for Women," in Karen Brodkin Sacks and Dorothy Remy, eds., **My Troubles Are Going to Have Trouble With Me** (New Brunswick, N.J.: Rutgers University Press, 1984), pp. 124-139.
Annette Fuentes and Barbara Ehrenreich, **Women in the Global Factory** (New York/Boston: Institute for New Communications/South End Press, 1983).
The Global Assembly Line [film], Wayne, N.J., New Day Films, 1986.
Philip Mattera, "Home Computer Sweatshops," **The Nation** (April 2, 1983): 390-393.
The Electronic Sweatshop [film], San Francisco, Calif., California Newsreel, 1985.

War and Weapons [Nov. 28-Dec. 1]
Dorothy Thompson, ed., **Over Our Dead Bodies: Women Against the Bomb** (London: Virago, 1983).
Sheila Tobias and Shelah Leader, "An Intelligent Woman's Guide to the Military Mind," **Ms.** 11 (July/August 1982): 118-120, 122, 252, 254, 257.
Brian Easlea, **Fathering the Unthinkable: Masculinity, Scientists and the Nuclear Arms Race** (London: Pluto Press, 1983).
Speaking Our Peace [film], National Film Board of Canada, 1985, order from Bullfrog Films, Oley, Penn.

Ecology/Appropriate Technology [Dec. 5-8]
Ynestra King, "Toward an Ecological Feminism and a Feminist Ecology," in Rothschild, **Machina Ex Dea**, pp. 118-129.
Carolyn Merchant, ed., "Women and the Environment," special issue **Environmental Review** 8 (Spring 1984).
Elizabeth Coppinger, "Women and Appropriate Technology," in Conference Proceedings, **Women and Appropriate Technology: Deciding What's Appropriate** (Missoula, Mont.: Women's Resource Center, 1979), pp. 24-25, plus selected articles.

VI. TECHNOLOGY, GENDER, AND THE FUTURE [Dec. 12-15]
Joan Rothschild, "Afterword: Machina Ex Dea and Future Research," in Rothschild, **Machina Ex Dea**, pp. 213-225.

Sally Gearhart, "An End to Technology: A Modest Proposal," in Rothschild, **Machina Ex Dea**, pp. 171-182.
Patrocinio Schweickart, "What If? ... Science and Technology in Feminist Utopias," in Rothschild, **Machina Ex Dea**, pp. 198-211.

Final Examination: Date to be announced

DETAILS OF PAPER/PRESENTATION ASSIGNMENT

Topic Choice: Due October 17

Presentation/Paper: Due Nov. 10 - Dec. 8 (see below)

For the second assignment, students are to select a topic from Part V of the Course Outline, "Gender and Technology: Current Issues," and prepare a class presentation/discussion and a short paper.

Topics and schedules are as follows:

Reproduction - Nov. 10 - 14
Computers/Automation - Nov. 17 - 21
War and Weapons - Nov. 28 - Dec. 1
Ecology/Appropriate Technology - Dec. 5 - Dec. 8

These presentations and papers are to be based largely on the assigned readings in Part V, for which all students are responsible. The Presenter's role will be to raise a provocative issue(s) or question(s) growing out of the readings on the topic, to develop briefly some dimension of the issue or question, and to conduct a class discussion. Avoid straight reports; they require no original thought and are boring. Students are asked particularly to raise issues that relate to values and choice, and therefore should be drawing as well on readings done earlier in the course.

There is no need for students to go beyond the assigned readings. But, because these are timely topics, students are encouraged to be alert for newspaper, magazine, or journal articles bearing on their topics to share with the rest of the class. The professor will supply additional sources as needed.

Students are encouraged to work in teams, rather than individually. After topic choice is made (by October 17), students are to confer with the professor about specific content so that duplication within a topic area can be avoided.

Papers are to be handed in on the day of the student's (s') presentation/discussion in class. Five pages, typed and double-spaced, will be the base length, longer for joint ventures: consult with the professor.

WOMEN AND TECHNOLOGY

Philip L. Bereano
Engineering Interdepartmental Curricular Program
University of Washington
Seattle, Washington

READINGS

The four books below are available for purchase at University Bookstore. In addition, there is an extensive list of required readings from many sources in a packet of xeroxed copies and on reserve in the library.

Barbara Garson, **All the Livelong Day** (New York: Penguin, 1977).
David Dickson, **The Politics of Alternative Technology** (New York: Universe, 1975).
Barbara Ehrenreich and Deirdre English, **For Her Own Good** (Garden City, New York: Doubleday, 1979).
Susan Strasser, **Never Done: A History of American Housework** (New York: Pantheon, 1982).

COURSE REQUIREMENTS

Participation, including asking questions. . . . . 40% of grade
Presentation on readings, and leading discussion for one class session 20%
10-15 page term paper 40%

4th week of class, 8th class period: Topics due. Submit one paragraph prospectus, including central questions to be answered, plus 1-2 sentences on significance of the problem and how you propose to research your topic.

9th week of class, 18th class period: Papers due. Submit original plus five copies. These five copies will be distributed to other students for additional comments. Papers may be subsequently revised for improvement in grade; due during finals week.

COURSE OUTLINE

[This quarter-length course meets bi-weekly, Editor]

(R) = required; usually part of xeroxed pocket, although sometimes on reserve at the library
(S) = supplementary; available on reserve at the library

INTRODUCTION

1. Introduction

Format of course, course requirements, grading system, topics covered, getting acquainted.
FILM: **Union Maids**, 48m, 1975 (New Day Film Coop., Inc., 22 Riverview Dr., Wayne, NJ 07470-3191)

PART I. TECHNOLOGY AND SOCIAL CHANGE

2. Technology and Society: Mainstream

Richard M. Peterson, **The Industrial Order and Social Policy** (Englewood Cliffs, N.J.: Prentice-Hall, 1972), ch. 2, pp. 11-19 ["The Industrial Revolution"]. (R)

D. Bell, "Five Dimensions of Post-Industrial Society," **Social Policy** 3 July/August 1973): 103-110. (R)

N. Wade, "Thomas A. Kuhn: Revolutionary Theorist of Science," **Science** 197 (July 8, 1977): 143-145. (R)

Thomas Kuhn, "Postscript," **The Structure of Scientific Revolutions**, 2nd ed., (Chicago: University of Chicago Press, 1970), pp. 174-210. SKIM. (R)

Emmanuel Mesthene, **Technological Change** (New York: New American Library, 1970), ch. 1, pp. 15-44 ["Social Change"]. (S)

3. Technology and Society: Radical

Harry Braverman, **Labor and Monopoly Capital** (New York: Monthly Review Press, 1974), chapter 7, pp. 155-168 ["The Scientific-Technical Revolution"]. (R)

Murray Bookchin, **Post-Scarcity Anarchism** (Berkeley, Calif.: Ramparts Press, 1971), pp. 9-30 ["Introduction"]. (R)

David Dickson, **The Politics of Alternative Technology** (New York: Universe Books, 1975), ch. 1, pp. 15-41 ["The Case Against Contemporary Technology"]. (R)

4. Women, Technology, and Society: Pre-industrial and Industrializing Societies

Ester Boserup, **Women's Role in Economic Development** (New York: St. Martin's Press, 1970), ch. 6, pp. 106-118 ["Industry: From the Hut to the Factory"]. (R)

Marshall Sahlins, **Stone Age Economics** (Hawthorne, N.Y.: Aldine Pub., 1972), pp. 14-32 ["Subsistence"] and pp. 74-82 ["Elements of the Domestic Mode of Production"]. (R)

5. Women, Technology, and Society: Industrial Societies

Ruth Cowan, "The Industrial Revolution in the Home: Household Technology and Social Change in the Twentieth Century," **Technology and Culture** 17 (Jan. 1976): 1-23. (R)

Judith Blake, "The Changing Status of Women in Developed Countries," **Scientific American** 231 (Sept. 1974): 137-147. (R)

Christine Bose, "Feminist Research in the Social Sciences," unpublished mimeograph, 1976. (R)

Corky Bush, "Women and the Assessment of Technology: To Think, to Be, to Unthink, to Free," in Joan Rothschild, ed., **Machina Ex Dea: Feminist Perspectives on Technology** (New York: Pergamon, 1983), pp. 151-170. (R)

PART II. TECHNOLOGY AND VALUES

6. On the Nature of Rationality

Hazel Henderson, "Philosophical Conflict: Re-examining the Goals of Knowledge," **Public Administration Review** 35 (Jan.-Feb. 1975): 77-80. (R)

Theodore Roszak, "The Monster and the Titan: Science, Knowledge, and Gnosis," **Daedalus** 103 (Summer 1974): 17-32. (R)

C. Frankel, "The Nature and Sources of Irrationalism," **Science** 180 (June 1, 1973): 927-931. (R)

7. Feminist Sensibilities

Shulamith Firestone, **The Dialectics of Sex** (New York: Bantam, 1970), ch. 10, pp. 192-202 ["Feminism and Ecology"]. (R)

Jane Dolkhaet and Nancy Hartsock, "Feminist Visions of the Future," and Noel Phyllis Borkby and Leslie Kanes Weisman, "A Woman Built Environment: Constructive Fantasies," **Quest** 2 (Summer 1975): 2-6. SKIM (R)

Elanor Maccoby and C. N. Jacklin. **The Psychology of Sex Differences** (Stanford, Calif.: Standford University Press, 1973), pp. 349-374. (R)

Jon Beckwithand John Durkin. "Girls, Boys and Math: Science and the Attack on Women," **Science for the People** 13 (Sept.-Oct. 1981): 6-9, 32-35. (R)

Susan Leigh Star, "Right and Left: An Examination of Sex Differences in Hemispheric Brain Asymmetry," paper, AAAS meeting, Washington, D.C., 1978. (R)

L Osen, "The Feminine Math-tique," in **Women in Mathematics** (Cambridge, Mass.: MIT Press, 1974). (S)

John Ernest, "Mathematics and Sex," **American Mathematical Monthly** 83 (Oct. 1976): 595-614. (S)

PART III. THE TECHNOLOGICAL ELITE

8. The Technological Elite

Barbara Ehrenreich and Deirdre English, **For Her Own Good**, ch. 1-3, pp. 1-100 ["Introduction" and "The Rise of the Experts"]. (R)

John McDermott, "Technology: The Opiate of the Intellectual," **New York Review of Books** 13 (July 31, 1969): 25-35. (R)

Hannah Arendt, "Lying in Politics: Reflections on the Pentagon Papers," **New York Review of Books** 17 (Nov. 18, 1971): 30-39. (R)

Bill Zimmerman, **et al.** "Towards A Science for the People," **Science for the People** 3 (December 1971). (S)

PART IV. THE DIVISION OF LABOR

9. The Workforce in the 19th Century

Mari Jo Buhle, Ann Gordon, and Nancy Schrom Dye. "Women in American Society: An Historical Contribution," **Radical America** 5 (July-Aug. 1971): 3-66, or New England Free Press Pamphlet. (R)

Elizabeth F. Baker, **Technology and Women's Work** (New York: Columbia University Press, 1964), ch. 2-4, pp. 8-74. SKIM (R)

Robert Smuts, **Women and Work in America** (New York: Columbia University Press, 1959), ch. 4, pp. 110-155 ["Women, Men, and Work: Values and Attitudes"]. (S)

10. Effects of Technology and Industrialization

David Dickson, **Politics of Alternative Technology**, ch. 2, pp. 41-62 ["The Ideology of Industrialization"] and ch 3, pp. 63-95 ["The Politics of Technical Change"]. (R)

M. Guilbert, "The Effects of Technological Change," **Impacts of Science on Society** (UNESCO) 3 (April-June 1970): 85-91. (R)

Harry Braverman, **Labor and Monopoly Capital** (New York: Monthly Review Press, 1974), ch. 5, pp. 293-308 ["Clerical Workers"]. SKIM (R)

Working Women. "Workers Face Office Automation," **Science for the People** 13 (May-June 1981): 5-9. (R)

R.L. Feldberg and Evelyn N. Glenn. "Technology and Work Degradation: Effects of Office Automation of Women Clerical Workers," in Joan Rothschild, ed., **Machina Ex Dea** (New York: Pergamon, 1983), pp. 59-78. (R)

Margery Davies, "Women's Place is at the Typewriter: The Feminization of the Clerical Labor Force," **Radical America** 8 (July-Aug. 1974): 225-261. (S)

Charlotte Perkins Gilman, **Women and Economics** (New York: Harper & Row, 1966), ch. 11-12, pp. 225-269. (S)

11. Vignettes and Participant Observations of Contemporary Women's Work

Barbara Garson, **All the Livelong Day** (New York: Penguin, 1977). (R)

Studs Terkel, **Working** (New York: Pantheon, 1974), pp. 57-69 [telephone receptionists], pp. 344-351 [bank teller], pp. 374-380 [supermarket checker]. Also suggested, pp. 72-82 [airline stewardess], pp. 161-168 [domestic], pp. 324-327 [cosmetic saleswoman], pp. 396-400 [housewife], pp. 451-456 [government bureaucrat], pp. 457-460 [government clerk], pp. 607-613 [bread baker], pp. 629-635 [teacher], pp. 642-646 [occupational therapist]. (S)

Elinor Langer, "The Women of the Telephone Company," **New York Review of Books** 14 (March 12, 1970): 16-27, 30. (S)

"Word Processing," **Seattle Times** (Feb. 18, 1977): H4. (S)

12. Theories and Descriptions

Rosalyn Baxandall, Elizabeth Ewen, and Linda Gordon, "The Working Class Has Two Sexes," **Monthly Review** 28 (July-Aug. 1976): 1-9. (R)

Heidi Hartman, "Capitalism, Patriarchy and Job Segregation by Sex," in Martha Blaxall and Barbara Reagan, eds., **Women and the Workplace: Implications of Occupational Segregation** (Chicago: University of Chicago Press, 1976), pp. 137-169. [Also in **Signs** 1 (Spring 1976)] (R)

Francine Blau and Carol Jusenious, "Economists' Approaches to Sex Segregation in the Labor Market: An Appraisal," in **ibid.**, pp. 181-199. [Also in **Signs**, above] (R)

Elise Boulding, "Familial Constraints and Women's Work Roles," in **ibid.**, pp. 95-117. [Also in **Signs**, above] (S)

Alice Cook, **The Working Mother** (New York: New York State School of Industrial and Labor Relations, 1975), ch. 10, pp. 40-50. (S)

Theodore Caplow, **The Sociology of Work** (Minneapolis: University of Minnesota Press, 1954), ch. 10, pp. 230-247 ["Occupations of Women"]. (S)

13 and 14. History of Housework

Susan Strasser, **Never Done: A History of American Housework** (New York: Pantheon, 1982), pp. 1-312. (R)

Ehrenreich and English, **For Her Own Good**, ch. 5, pp. 141-182 ["Microbes and the Manufacture of Housework"]. (R)

Nona Glazer, "Housework," **Signs** 1 (Summer 1976): 905-922. (R)

Ann Oakley, **Women's Work: The Housewife, Past and Present** (New York: Random, 1976). (S)

Ruth Cowan, "Two Washes in the Morning and a Bridge Game at Night," **Women's Studies** 3 (1976): 147-172. (S)

Molly Harrison, **The Kitchen in History** (New York: Charles Scribner & Sons, 1972), esp. ch. 9, pp. 103-128 ["The Nineteenth Century"]. (S)

Evelyn Reed, **Women's Evolution** (New York: Pathfinder Press, 1975), ch. 5, pp. 105-120 ["The Productive Record of Primitive Women"]. (S)

G. Wright, "Sweet and Clean: The Domestic Landscape in the Progressive Era," **Landscape** 20 (October 1975): 38-43. (S)

"Homemaking and Womanhood," **Dollars & Sense** 51 (Nov. 1979): 6-8.

15. Working Conditions of Housework: Time, Technology, and Ideology

Ann Oakley, **The Sociology of Housework** (New York: Pantheon, 1974), ch. 5, pp. 79-99 ["Work Conditions"]. SKIM (R)

Valerie K. Oppenheimer, **The Female Labor Force in the U.S.** (Berkeley, Calif.: University of California Press, 1970), esp. pp. 29-39. (R)

Christine Bose, Philip Bereano, and Mary Malloy, "Household Technology and the Social Construction of Housework," **Technology and Culture** 25 (Jan. 1984): 53-82.

Joann Vanek, "Time Spent in Housework," **Scientific American** 231 (Nov. 1974): 116-120. (R)

Kathryn Walker and Margaret Woods, **Time Use** (Washington, D.C.: Center for the Family and the American Home Economics Assn., 1976), ch. 9, pp. 246-273 ["Summary"]. (R)

Pat Mainardi, "The Politics of Housework," in R. Morgan, ed., **Sisterhood is Powerful** (New York: Random House, 1970), pp. 447-454. (R)

Scott Burns, "The Shift from a Market Economy to a Household Economy," **Coevolution Quarterly** 11 (Fall 1976): 18-29. (S)

Margaret Reid, **The Economics of Household Production** (New York: John Wiley, 1934). (S)

Ruth Cowan, "A Case Study of Technological and Social Change: The Washing Machine and the Working Wife," in Mary S. Hartman and Lois Banner, eds., **Clio's Consciousness Raised** (New York: Harper Colophone, 1974), pp. 245-253. (S)

Sarah Berk, Richard Berk, and Catherine Berheide, "Household Work in the Suburbs," **Pacific Sociological Review** 19 (Oct. 1976): 491-518. (S)

Marvin Harris, **The Nature of Cultural Things** (New York: Random House, 1964), pp. 72-75 [on episode chains in kitchen]. (S)

Joann Vanek, "Household Technology and Social Status: Rising Living Standards and Status and Residence Differences in Housework," **Technology and Culture** 19 (July 1978): 361-375. (S)

16. Wages for Housework

Wendyce Brody, "Economic Value of a Housewife," U.S. Social Security Administration, Aug. 28, 1975. (R)

Joan Landes, "Wages for Housework," **Quest** 2 (Fall 1975): 17-30. (R)

B. Ehrenreich, **New American Movement** (March 1975); B. Dudley, **New American Movement** (May 1975); J. Breenleaf, **WIN** (July 3, 1975). (R) [political journals now defunct]

William H. Gauger and Kathryn E. Walker, "The Dollar Value of Household Work," Bulletin #60, New York State College of Human Ecology, Cornell University, Ithaca, New York, 2nd ed., 1980. (R)

A. Szalai, "The Situation of Women in the Light of Contemporary Time-Budget Research," U.N. Background Paper for the World Conference on International Women's Year, April 15, 1975. (S)

Chase Manhattan Study, "What's a Wife Worth?" **Houseworker's Handbook**, pp. 17-18. (S)

17. Consumerism

Herbert Marcuse, **One-Dimensional Man** (Boston: Beacon, 1964), pp. ix-xvii ["Introduction"] and pp. 1-18 ["The New Forms of Control"]. (R)

Ellen Willis, "Women and the Myth of Consumerism," **Ramparts** 8 (June 1970): 13-16. (R)

Batya Weinbaum and Amy Bridges, "The Other Side of the Paycheck: Monopoly Capital and the Structure of Consumption," **Monthly Review** 28 (July-Aug. 1976): 88-103. (R)

PART V. WOMEN AND ALTERNATIVE TECHNOLOGY

18. Women and Alternative Technology

E. F. Schumacher, **Small is Beautiful** (New York: Harper & Row, 1973), ch. I-3, pp. 38-49 ["The Role of Economics"], I-14 and I-15, pp. 138-151 ["Buddhist Economics" and "Technology with a Human Face"]. (R)

D. Dickson, **The Politics of Alternative Technology** (New York: Universe, 1975), ch. 7, pp. 174-204 ["Myths and Responsibilities"]. (R)

J. Smith, **Something Old, Something New, Something Borrowed, Something Due: Women and Appropriate Technology**, Women and Technology Project, Missoula, Montana, 28 page pamphlet, 1980. (R)

"Appropriate Technology for Women," **U.N. Development Forum** (June 1978): 3-4. (R)

PART VI. BIOMEDICAL TECHNOLOGIES

19. Women: Sickness and Health

Ehrenreich and English, **For Her Own Good**, ch. 4, pp. 101-140 ["The Sexual Politics of Sickness"]. (R)

Ehrenreich and English, **For Her Own Good**, ch. 7-8, pp. 211-268 ["Motherhood and Pathology" and "From Masochistic Motherhood to the Sexual Marketplace"]. (S)

20. Birthing, Birth Control, and Abortion

Rita Arditti, "Male Contraception," **Science for the People** 8 (July 1976): 12-15, 35. (R)

Linda Gordon, "Birth Control: An Historical Study," **Science for the People** 9 (Jan.-Feb. 1977): 10-16. (R)

Linda Gordon, "Birth Control and the Eugenists," **Science for the People** 9 (March-April 1977): 8-15. (R)

Adrienne Rich, **Of Woman Born: Motherhood as Experience and Institution** (New York: Bantam, 1977), ch. 6, pp. 128-155 ["Hands of Flesh, Hands of Iron"]. (R)

PART VII. ARCHITECTURE AND PHYSICAL SPACES

21. Architecture and Physical Spaces

Dolores Hayden, **Grand Domestic Revolution** (Cambridge, Mass.: MIT Press, 1981), pp. 3-29 ["Introduction"] and pp. 291-305 ["Feminist Politics and Domestic Life"]. (R)

Susan Saegert, "Masculine Cities and Feminine Suburbs: Polarized Ideas, Contradictory Realities," in Catherine R. Stimpson, Elsa J. Dixler, Martha G. Nelson, and Kathryn B. Yatrakis, eds., **Women and the American City** (Chicago: University of Chicago Press, 1981), pp. 93-108. (R)

Dolores Hayden, "What Would a Non-Sexist City Be Like? Speculations on Housing, Urban Design and Human Work," in **ibid.**, pp. 167-184. (R)

Gerde Wekerle, "Women in the Urban Environment," in **ibid.**, pp. 185-211. (R)

Heresies, #11, Making Room: Women and Architecture (1981): Nunzia Rondanini, "Architecture and Social Change," pp. 3-5; Leslie Kanes Weisman, "Women's Environmental Rights: A Manifesto," pp. 6-8; and Margrit Kennedy, "Seven Hypotheses on Female and Male Principles in Architecture," pp. 12-13. (R)

Gerde R. Wekerle, Rebecca Paterson, and David Morely, eds., **New Space for Women** (Boulder, Colo: Westview Press, 1980), pp. 205-218 ["Architecture: Towards a Feminist Critique"] and other chapters on design of the home. (S)

APPENDIX

Briefly Annotated Additional Course Materials

APPENDIX

BRIEFLY ANNOTATED ADDITIONAL COURSE MATERIALS

The following is a list of course materials that were reviewed for inclusion in either the first (1983) or present (1987) editions of **The Machine in the University**, plus some additional course descriptions included at the request of their authors. Many of these are excellent courses which could not be reprinted in full for any of a variety of reasons (briefness of the outline submitted, specialized focus, similarity to syllabi reproduced, space limitations, etc.). To insure that those who might be interested in these courses have some access to them, the present editor and the TS&E Committee elected to continue the procedure followed in the first edition--i.e., provide a briefly annotated list of syllabi not reprinted in full. Presumably each of the individuals teaching these courses would be willing to share his or her ideas and materials with those desirous of further information. Contact should be made directly with the individual, rather than through the editor or the TS&E Committee.

In compiling the list which appears below, the present editor attempted to determine if courses listed in the 1983 edition were still being taught by sending an inquiry to all instructors listed in the 1983 edition. I have excluded from the following list courses taught by instructors who indicated that their courses were no longer being taught. I have placed "(1987)" after the titles of courses taught by instructors who indicated that their 1983 courses were still being taught and after new additions to the list. I have placed "(1983)" after those course titles whose instructors did not respond one way or the other to my inquiries.

The organization of the annotated course list follows the general outline of the work as a whole:

Section I. Technology in History
- A. Technology in World History
- B. Technology in American History
- C. Themes in the History of Technology

Section II. Technology in the Contemporary World
- A. Introduction to Technology Studies
- B. Technology Literacy
- C. Themes in Technology Studies

Within each sub-section courses are listed alphabetically by title. Since some courses, especially in Section II, overlap several areas readers should consider looking in related sub-sections.

SECTION I: TECHNOLOGY IN HISTORY

A. Technology in World History

THE EMERGENCE OF WESTERN TECHNOLOGY (1987)

The second half of a two-semester sequence (the first half is an introductory physical science course) that explores a variety of social and value questions related to science and technology. Utilizes a historical theme as the teaching vehicle. Extensive lecture notes provide a detailed outline of the course. [STEVEN DUTCH; College of Environmental Sciences; University of Wisconsin-Green Bay; Green Bay, WI 54302]

ENGINEERING AND TECHNOLOGY IN HISTORY (1987)

A one-semester survey covering the sweep of history from the ancients to the space-age. Students receive an extensive compendium, including lecture notes, graphics illustrating certain technological developments, study questions, and bibliographical suggestions. [J. PAUL HARTMAN; College of Engineering; University of Central Florida; Orlando, FL 32816-0450]

ENGINEERING IN WESTERN CIVILIZATION (1987)

The interaction of technology, science, and society from Paleolithic stone tools to 20th-century scientific-based technology are briefly covered in this one-semester survey. A well-balanced treatment of topics given the course's length. [KATHLEEN H. OCHS, Humanities and Social Sciences Department; Colorado School of Mines; Golden, CO 80401]

FIRE AND STRUCTURES (1987)

Good example of the use of the history of technology as a medium for imparting technological literacy. Technological developments are exemplified in selected themes: the ceramic and metallurgical uses of fire from preliterate plaster to open hearth steel; heat engines from Newcomen to Diesel; the stability of masonry from the Egyptian pyramids to Gothic cathedrals; long-span bridges from cast-iron arches to suspension bridges and steel trusses. Based on a textbook written by the instructor specifically for this course. [ALFRED ROMER; St. Lawrence University; Canton, NY 13617]

GREAT MOMENTS IN ENGINEERING (1983)

A semester-long topical and thematic treatment of the history of engineering covering developments such as the steam engine, bridge building, industrial research laboratories, the assembly line, the computer, nuclear engineering, and space technology. [DAVID HOUNSHELL; Department of History; University of Delaware; Newark, DE 19711]

HISTORY AND TECHNOLOGY (1983)

This one-semester course covers the period from the ancient world to the 20th century, but the bulk of the survey focuses on the Industrial Revolution. Includes sample examinations. [PEDRO THOMAS MEZA; Queensboro Community College; Springfield Blvd. and L.I. Expressway; Bayside, NY 11364]

HISTORY OF TECHNOLOGY (1983)

Two-semester sequence covering the development of technology and engineering from antiquity to the mid-twentieth century. Printed in full in **The Machine in the University**, first edition, pp. 41-54. [JAMES H. SCHAUB; Department of Civil Engineering; University of Florida; Gainesville, FL]

HISTORY OF TECHNOLOGY (1987)

One term overview of the history of technology from the ancients to present. Good list of readings. Reprinted in full in **The Machine in the University**, first ed., pp. 65-68. [HOWARD P. SEGAL; Department of History; University of Maine; Orono, ME 04469]

THE HISTORY OF TECHNOLOGY (1983)

This semester-long survey of technology in western civilization from ancient times concentrates on the 19th and 20th centuries, especially in the United States. Sample exam questions are included. [DANIEL A. MILLER; Chairman, Division of Social Sciences; Indiana State University-Evansville; 8600 Univ. Boulevard; Evansville, IN 47712]

HISTORY OF TECHNOLOGY: TECHNOLOGY IN WESTERN SOCIETY - RENAISSANCE TO MID-19TH CENTURY; TECHNOLOGY IN WESTERN SOCIETY - 1870 TO THE PRESENT (1987)

A two-term survey of the history of technology similar in scope to the Hirsh three-term survey printed in full in this volume. Readings largely consist of short articles instead of a textbook. [THOMAS J. MISA; Department of History; Virginia Polytechnic Institute; Blacksburg, VA 24061]

HISTORY OF TECHNOLOGY AND ENGINEERING (1983)

A two-semester survey breaking at approximately 1750 with the Industrial Revolution, utilizing a lecture and tutorial format and covering fairly standard topics. Designed primarily to introduce engineering students to the societal contexts of technology and engineering. [BERT S. HALL; University of Toronto; 280 Huron St., Rm. 406; Toronto, CANADA M5S 1A1]

AN INTRODUCTION TO ENGINEERING TO ENHANCE HISTORICAL AND SOCIAL PERSPECTIVES (1983)

A narrative summary of the development of an introductory course for engineers on the history of engineering and the social impact of technology that focuses on the innovative process. Includes references for possible texts. [RICHARD ASTON AND JEAN DRISCOLL; Engineering Dept.; Wilkes College; P.O. Box 111; Wilkes-Barre, PA 18766]

INTRODUCTION TO THE HISTORY OF TECHNOLOGY (1983)

A thematic survey of the history of technology from roughly the Middle Ages to the 20th century that utilizes Mumford's **Technics and Civilization** as an interpretive framework for understanding this history and the discipline itself. A thought-provoking approach. [DAVID HOUNSHELL; Department of History; University of Delaware; Newark, DE 19711]

INTRODUCTION TO THE HISTORY OF TECHNOLOGY (1983)

A departmentally team-taught, one-semester survey of technology in world history. Selected topical coverage. [MARVIN LUNENFELD; Department of History; State University College; Fredonia, NY 14063]

SOCIETY AND THE ECONOMIC TRANSITION (1987)

A semester-long course dealing with the history of technology but with some nice and unique twists. The course focuses on four societies--hunting-gathering, settled agricultural, industrial, and bureaucratic-planning--looking at their

technology and supporting socio-economic institutions. Two of the four texts used are novels [Dickens' **Hard Times** and Kesey's **One Flew Over the Cuckoo's Nest**]. [CHARLES K. HYDE; Department of History; Wayne State University; Detroit, MI 48202]

TECHNOLOGY AND CIVILIZATION: HONORS SEQUENCE (1983)

This solid and standard, three-quarter length, lecture course covers the central topics in the history of technology from the ancient world to the present. Slide illustrated. Printed in full in **The Machine in the University**, first ed., pp. 55-64. [W. DAVID LEWIS; Department of History; Auburn University; 7030 Haley Center; Auburn, AL 36849]

TECHNOLOGY AND WESTERN CIVILIZATION: ANCIENT AND MEDIEVAL, RENAISSANCE TO INDUSTRIAL REVOLUTION, 19TH AND 20TH CENTURIES (1987)

A solid and fairly standard, year-long three-quarter sequence emphasizing the major technological topics in the history of Western civilization from the ancient world to the 20th century. [EDWIN LAYTON; Dept. of Mechanical Engineering; University of Minnesota; 125 Mechanical Engineering; Minneapolis, MN 55455]

TECHNOLOGY, ENGINEERING AND SOCIETY (1983)

This semester-length course focuses on three major themes in the history of science, technology, and engineering from 1750 to 1945: the relationship of science and technology, the development of industrial research, and the changing social role of the engineer. [P. B. WOOD; Institute for History and Philosophy of Science and Technology; University of Toronto; Toronto, Ontario, CANADA M5S 1A1]

TECHNOLOGY IN HISTORY (1987)

This course uses selected innovations and inventions to trace the evolution of technology, to explore the process of innovation and invention, and to illustrate the impact of technology on civilization. [EDWARD C. PYTLIK; Technology Education Program; West Virginia University; Morgantown, WV 26506-6122]

TECHNOLOGY IN HISTORY (1983)

Introduction to the history of Western technology from medieval agriculture to the second industrial revolution of the late nineteenth century. Reprinted in full in **The Machine in the University**, first ed., pp. 69-72. [JEFFREY L. STURCHIO; Center for the History of Chemistry; University of Pennsylvania; Philadelphia, PA 19104]

TECHNOLOGY: ITS HISTORY AND DEVELOPMENT (1987)

A study of the major technological periods in history and the interrelationship of technological development to the social/cultural milieu. Specific themes covered include: man as toolmaker, manufacturing and production, mining and metallurgy, food production, energy production, and developments in construction, transportation, and communication. [EDWARD C. PYTLIK; Technology Education Program; West Virginia University; Morgantown, WV 26506-6122]

B. Technology in American History

AMERICAN TECHNOLOGY AND SOCIETY: HISTORICAL PERSPECTIVES (1987)

A one-semester survey of American technology focusing primarily on the Industrial Revolution, its societal impact, and the resultant response. [HOWARD P. SEGAL; Department of History; University of Maine; Orono, ME 04469]

CIVILIZING THE MACHINE: HISTORY OF AMERICAN TECHNOLOGY (1983)

Overview of the history of American technology with a core focused on student research papers dealing with the history of technology in a local context. Reprinted in full in **The Machine in the University**, first ed., pp. 85-89. [JAMES C. WILLIAMS; California History Center & Foundation; DeAnza College, Cupertino, CA 95014]

ENGINEERING AND TECHNOLOGY IN AMERICA (1987)

A one-semester, two-hour credit survey covering the colonial period through World War II. Students receive a compendium which includes a bibliography, maps, museum sources, lecture outline notes, study questions, diagrams, etc. [J. PAUL HARTMAN; College of Engineering; University of Central Florida; Orlando, FL 32816-0993]

ENGINEERING AND TECHNOLOGY IN CANADA (1987)

A one-semester, two-hour credit survey of historic and contemporary developments in engineering and technology in Canada. Students receive a compendium which includes a bibliography, maps, museum sources, lecture outline notes, review questions, etc. This is part of the University of Central Florida Canadian Studies Programme. [J. PAUL HARTMAN; College of Engineering; University of Central Florida; Orlando, FL 32816-0993]

HISTORY OF AMERICAN TECHNOLOGY (1987)

A well-balanced, one-semester survey focusing on the broader social context of American technology. Includes useful sample essay and exam questions. [P. THOMAS CARROLL; Department of Science and Technology Studies; Rensselaer Polytechnic Institute; Troy, NY 12180-3590]

HISTORY OF TECHNOLOGY IN AMERICA, I (1776-1876) and II (SINCE 1876) (1983)

Solid two semester sequence using a colloquium format. Full syllabus reprinted in **The Machine in the University**, first ed., pp. 107-116. [DAVID F. NOBLE and MERRITT ROE SMITH; Program in Science, Technology and Society; Massachusetts Institute of Technology; Cambridge, MA 02139]

INDUSTRIALIZATION OF AMERICA (1987)

One-term overview of the role of technology in American economic and industrial development from the colonial period to the 20th century. [TERRY S. REYNOLDS and LARRY D. LANKTON; STS Program; Michigan Technological University; Houghton, MI 49931]

THE MACHINE IN AMERICA (1983)

A two-semester survey of American technology breaking at approximately 1900 with a balanced selection of topics covered. [CARROLL PURSELL; Dept. of History; University of California-Santa Barbara; Santa Barbara, CA 93106]

THE MACHINE IN AMERICA (1983)

The machine as a cultural phenomenon, "as a builder and destroyer of values," is the primary theme of this one-semester survey of American technology. The focus of the course is on the late-19th and 20th centuries. [NEIL L. YORK; Department of American Studies; 133 FOB; Brigham Young University; Provo, UT 84602]

MAN AND MACHINES IN AMERICAN HISTORY (1983)

A two-semester seminar treatment with a good list of readings for each of the standard topics. [BRUCE SINCLAIR; Inst. for History and Philosophy of Science; University of Toronto; Toronto, CANADA M5S 1A1]

TECHNOLOGY AND MATERIAL CULTURE IN AMERICA (1983)

A two semester sequence breaking at 1860 examining the processes, products, and social effects of American technology, which teaches students to use material objects as evidence in the study of history. Reprinted in full in **The Machine in the University**, first ed., pp. 117-124. [PATRICK M. MALONE; American Civilization Program; Brown University; Providence, RI 02913]

TECHNOLOGY IN AMERICA (1987)

A one-semester survey of the history of American technology from the colonial period to computers in modern American society. Good coverage of central topics. [CHARLES K. HYDE; Department of History; Wayne State University; Detroit, MI 48202]

TECHNOLOGY IN AMERICAN HISTORY (1983)

Introduction to the role of technology in American history. Excellent guide to further reading. Reprinted in full in **The Machine in the University**, first edition, pp. 75-83. [JEFFREY L. STURCHIO; Center for the History of Chemistry; University of Pennsylvania; Philadelphia, PA 19104]

C. Themes in the History of Technology

AMERICAN BUSINESS AND TECHNOLOGY SINCE 1890 (1987)

The organization, routines, techniques, market strategies, and innovations of American business are the focus of this quarter-length course. In addition, the impact of business decisions and technologies upon urban development, educational and political institutions, labor, and the family are examined. [MARK H. ROSE; Program in Science, Technology and Society; Michigan Technological University; Houghton, MI 49931]

THE ART AND PHYSICS OF STRUCTURAL ENGINEERING (1987)

Course combines the history of structures with lessons on the basic physics of large-scale structures. Among the structures covered are the Brooklyn Bridge, the Eiffel Tower, skyscrapers, reinforced concrete, and Maillart. [BOB PRIGO; Department of Physics; Middlebury College; Middlebury, VT 05753]

THE AUTOMOBILE IN AMERICA, 1890-1980 (1987)

The development and impact of the automobile on American life. Reprinted in full in **The Machine in the University**, first ed., pp. 133-135. [MARK H. ROSE; Program in Science, Technology, and Society; Michigan Technological University; Houghton, MI 49931]

HUMANISTIC RESPONSES TO TECHNOLOGICAL CHANGE and HUMANISTIC RESPONSES TO TECHNOLOGICAL CHANGE: THE CULTURE OF WORK (1983)

A two-quarter sequence, the first half of which focuses on changing perceptions of society in the 19th and early 20th centuries. The second half concentrates on the changing nature and perception of work during the same period. [HENRY C. BINFORD and CARL SMITH; Depts. of History and English; Colleges of Arts and Sciences; Northwestern University; Evanston, IL 60201]

INTRODUCTION TO MASS MEDIA (1983)

The history of mass communications, including writing, printing, photography, telegraphy, the telephone, the phonograph, motion pictures, radio, and television. Each is examined in its broader social context. [PAUL LEVINSON; Communications, Speech and Theatre; Fairleigh Dickinson University; Teaneck, NJ 07666]

LITERATURE AND TECHNOLOGY (1983)

An examination of literary responses to technology, particularly since the Industrial Revolution, focusing on such themes as worker alienation, the impact of machine production, and technological utopianism. Includes sample theme topics and the final exam. [HOWARD P. SEGAL; Department of History; University of Maine; Orono, ME 04469]

PERSPECTIVES IN TECHNOLOGY AND ENVIRONMENT (1983)

An intriguing historical analysis of the interactions between technology and the environment, utilizing perspectives from other disciplines as well. Covers roughly the years of 1500-1850, setting the course theme within the context of the major technological developments of the period. [A. HUNTER DUPREE; Dept. of History; Brown University; Providence, RI 02913]

SCIENCE FICTION AS INTELLECTUAL HISTORY (1983)

An examination of classic science fiction novels as historical documents that reveal the political, social, intellectual, economic, and military circumstances of the period in which they were written. Authors studied include Mary Shelley, Jules Verne, H.G. Wells, Aldous Huxley, Arthur C. Clarke, and Colin Wilson. [W. DAVID LEWIS; History Department; Auburn University; 7030 Haley Center; Auburn, AL 36849]

STRUCTURE IN ARCHITECTURAL HISTORY (1987)

A seminar (team-taught by a structural research engineer and an architectural historian) that seeks to understand the relationships between structural technology and the architecture of large historical buildings and monuments. [ROBERT MARK and SLOBODAN CURCIC; School of Architecture; Princeton University; Princeton, NJ 08544]

STUDIES IN THE HISTORY OF IDEAS: THE HISTORY OF THE COMPUTER (1987)

The core of this course focuses on the period ca. 1935-50 and relates the development of the modern electronic digital computer to broader scientific, industrial, and economic trends. Includes a list of additional readings. Taught at Clemson through 1984. [PAUL CERUZZI; Associate Curator, National Air and Space Museum; Smithsonian Institution; Washington, D.C. 20560]

TECHNOLOGY AND AMERICAN CITIES, 1850-1980 [now titled URBAN AMERICA] (1987)

The impact of technological systems on the growth and development of American cities and the role of society in shaping these systems. Reprinted in full in **The Machine in the University**, first ed., pp. 137-139. [MARK H. ROSE; Program in Science, Technology, and Society; Michigan Technological University; Houghton, MI 49931]

TECHNOLOGY IN HISTORICAL PERSPECTIVE (1983)

A study of four major engineering projects and their social, political, economic, and scientific contexts. Topics include the Panama Canal, the Brooklyn Bridge, the Wright Brothers, and the Apollo project, with an emphasis on those factors influencing design and construction and a feeling for system behavior. [FRANCIS E. GRIGGS; Dept. of Civil Engineering; Union College; Schenectady, NY 12308]

TECHNOLOGY, USA STYLE: MASCULINE-FEMININE IMBALANCES (1987)

A term-length course which concentrates on the ways in which so-called "masculine and feminine" traits have influenced and been influenced by America's technological style. [JOHN M. STAUDENMAIER; Department of History; University of Detroit; Detroit, MI 48221]

THOMAS JEFFERSON'S INTERESTS IN SCIENCE AND TECHNOLOGY (1983)

A specialized course probing Jefferson's interests in science and technology and how those interests contributed to his life and works. Reprinted in full in **The Machine in the University**, first ed., pp. 141-144. [O. ALLAN GIANNINY; Division of Humanities; School of Engineering; University of Virginia; Charlottesville, VA 22901]

TOPICS IN THE IMPACT OF TECHNOLOGY (1987)

This semester-long course looks at the impact of three technologies on society: automobiles, nuclear weapons, and computers/microelectronics. Focus is heavily, though not exclusively, American. [CHARLES K. HYDE; Department of History; Wayne State University; Detroit, MI 48202]

PART II: TECHNOLOGY IN THE CONTEMPORARY WORLD

A. Introduction to Technology Studies

AMERICAN LIVES AND THE SEARCH FOR COMMUNITY (1983)

An examination of technology's impact upon the individual and his or her relationship to society and its religious, cultural, and political institutions. [DAVID LAIRD; California State University; 5151 State Univ. Drive; Los Angeles, CA 90032]

CULTURE AND TECHNOLOGY (1983)

An interdisciplinary look, primarily literary and sociological, at some of the major cultural issues confronting modern technological society, issues such as the implications of growing complexity and specialization, the tensions between

efficiency and moral, aesthetic, or religious standards of value, political questions related to attempts to control and direct technology, and the issue of technologically-induced alienation. [DAVID LAIRD; California State University; 5151 State Univ. Drive; Los Angeles, CA 90032]

INTRODUCTION TO TECHNOLOGY (1987)

"An introduction to the evolution of technical systems and the relation of these systems to technological change and the civilization process." [PAUL W. DEVORE; Technology Education Program; West Virginia University; Morgantown, WV 26506-6122]

MAN, SOCIETY AND TECHNOLOGY (1983)

A one-semester interdisciplinary treatment of the relationship of technology to society. Includes a focus on several specific themes -- ecology, energy, technological alternatives -- in addition to the general theme of cultural development as related to technological quality. [JOHN EPHRAIM; Dept. of Technology; School of Applied Science and Technology; East Tennessee State University; Johnson City, TN 37601]

MAN/TECHNOLOGY/SOCIETY (1983)

A semester-length survey of the relationship of technology to society that takes a largely historical approach. The course is divided into roughly equal quarters devoted to ancient and medieval technology, the Industrial Revolution in Britain and America, the response to the American Industrial Revolution, and current problems of technology in society. [GEORGE H. MERRIAM; Department of History; Fitchburg State College, Fitchburg, MA 01420]

SCIENCE, TECHNOLOGY, AND SOCIETY: IMPACTS AND INTERRELATIONSHIPS (1987)

An interdisciplinary, introductory course designed to present students with an appreciation of some of the many interrelationships between science, technology, and society and to the area of technology studies. Specific topics covered vary from term to term. Taught by a variety of faculty. [TERRY S. REYNOLDS, Program in Science, Technology, and Society; Michigan Technological University; Houghton, MI 49931]

SOCIAL CONSEQUENCES OF TECHNOLOGY (1983)

Following a brief historical analysis of technological development since the Industrial Revolution in which technology is viewed as "the driving force of change," the course takes up a number of contemporary technologically related cases -- capitalism, class struggle, business cycles, poverty, the arms race, cities, and resources. The course ends with a section on suggestions for problem-solving. Detailed study questions for each topic are included. [FRED L. WILSON; College of General Studies; One Lomb Memorial Drive; Rochester Institute of Technology; P.O. Box 9887; Rochester, NY 14623]

SOCIETY AND TECHNOLOGY (1987)

A study of certain aspects of the relationship between technology and society. Topics include the impact of technology on social structures and the quality of life and work; environment, resources, and limits to growth; technology transfer; the ethical and social responsibilities of engineers; and the problems of forecasting, assessing and controlling technology. [PETER F. LIMPER; Christian Brothers College; 650 East Parkway South; Memphis, TN 38104]

STUDIES IN PHILOSOPHY AND TECHNOLOGY (1987)

A repeatable senior/graduate-level course which provides a "philosophical examination" of specific technological systems or technology in general, paying particular attention to its interrelationships with and mutual dependence on society, culture, and human values. [WILLIAM B. JONES; Deptartment of Philosophy; Old Dominion University; Norfolk, VA 23508]

THE TECHNOLOGICAL SOCIETY (1983)

"An interdisciplinary analysis of the social and ecological crisis caused by the exponential growth of science and technology. The issues -- population, energy, alienation, pollution, etc. -- are examined on the global, national, and local levels." [J. P. RASMUSSEN; California State College, Stanislaus; Turlock, CA 95380]

TECHNOLOGY: A HUMAN ENDEAVOR (1987)

An "analysis of the study of technology for policy-oriented decision makers in various fields." Stresses the formative role of technology in shaping policy using a somewhat historical perspective. [GARY E. LINTEREUR; Northern Illinois University; College of Engineering and Engineering Technology; Dept. of Industry and Technology; DeKalb, IL 60115]

TECHNOLOGY AND CHANGE (1983)

A combination of historical and contemporary topics are examined to show the relationship of economic, political, and social contexts to technological developments. [R. J. MORRIS; Department of General Science; Oregon State University; Corvallis, OR 97331]

TECHNOLOGY AND CULTURAL RELEVANCE (1987)

The relationship of technology to society and values in a future context. Topics include transportation, work, and leisure, education, genetics, the city, energy, personal relationships, and technology forecasting. [GARY E. LINTEREUR; Northern Illinois University; College of Engineering and Engineering Technology; Dept. of Industry and Technology; DeKalb, IL 60115]

TECHNOLOGY AND SOCIETY (1987)

The course analyzes the relationship between technical means, change, and society. Emphasis is on the impact of technical change on the social institutions and the culture of various societies. [EDWARD C. PYTLIK; Technology Education Program; West Virginia University; Morgantown, WV 26506-6122]

TECHNOLOGY AND SOCIETY (1983)

This course covers a range of topics including the historical development of technology, contemporary questions of population, energy and the environment, ethical issues surrounding the use of technology, future shock, and technology assessment. Utilizes a variety of simulations, film and video-tape-based discussions, and debate techniques to involve the students. [GEORGE C. LINDAUER; Speed Scientific School; University of Louisville; Belknap Campus; Louisville, KY 40292]

TECHNOLOGY AND SOCIETY (1983)

This 10-week course is divided into two halves, the first historical and the second contemporary with a focus on human values questions. The historical focus is American, while the values-oriented segment includes questions of an

international scope such as computers, resources and nature, world peace, and human freedom. Includes sample study questions and paper topics. [VICTORIA PUNDSACK; College of Applied Science; University of Cincinnati; #103 M.L.; Cincinnati, OH 45220]

TECHNOLOGY AND SOCIETY (1987)

An essay summary of an interdisciplinary course that analyzes, through a lecture/discussion format, both the scientific basis and the values implications of topics including: industrial technology, energy, biotechnology, computers, and food technology. The final portion of the course is devoted to learning about the techniques and actually conducting a technology assessment. Sample exam questions available. [NANCY SELL; ES 317; University of Wisconsin-Green Bay; Green Bay, WI 54302]

TECHNOLOGY AND SOCIETY (1983)

A 25-week long, team-taught course dealing with the influence of technology upon various aspects of society. 6-week modules cover: engineering and social purposes, energy options, work, and agricultural and industrial development. Lecture/discussion format; includes study/essay questions for each module. [STAFF, DEPARTMENT OF CHEMICAL ENGINEERING; University of British Columbia; 2216 Main Hall; Vancouver, B.C.; CANADA V6T 1W5]

TECHNOLOGY AS CULTURE (1987)

"An examination of the cultural and political effects of technology," as well as "the cultural factors that accelerated the exploitation and growth of technology in Western society." A historical background is followed by a comparison of technologically simple and advanced societies. [M. V. SUSSMAN; Tufts University; Medford, MA 02155]

B. Technology Literacy

THE ART AND PHYSICS OF STRUCTURAL ENGINEERING (1987)

Course combines the history of structures with lessons on the basic physics of large-scale structures. Among the structures covered are the Brooklyn Bridge, the Eiffel Tower; skyscrapers, reinforced concrete, and Maillart. [BOB PRIGO; Department of Physics; Middlebury College; Middlebury, VT 05753]

CONTEMPORARY PROBLEMS IN PRODUCTION (1987)

A course which reviews the technical, social, and cultural problems which result from the development of new and improved methods of producing goods, services and information. Course uses "a scenario approach" to give students an insight into major modern production systems, their organization, their modes of operation, methods of research and development, major problems, and impact on society. [EDWARD C. PYTLIK; Technology Education Program; West Virginia University; Morgantown, WV 26506-6122.

FIRE AND STRUCTURES (1987)

Good example of the use of the history of technology as a medium for imparting technological literacy. Technological developments are exemplified in selected themes: the ceramic and metallurgical uses of fire from preliterate plaster to

open hearth steel; heat engines from Newcomen to Diesel; the stability of masonry from the Egyptian pyramids to Gothic cathedrals; long-span bridges from cast-iron arches to suspension bridges and steel trusses. Based on a textbook written by the instructor specifically for this course. [ALFRED ROMER; St. Lawrence University; Canton, NY 13617]

INTERMEDIATE TECHNOLOGY (1987)

Designed to consider whether appropriate technology (AT) can actually meet relevant human physical needs combined with desirable personal and social benefits. A general understanding of AT and its possible benefits are combined with a close look at the actual workings of specific technologies such as wind and water power generators, aqua-culture, and methane digesters. [BARRETT HAZELTINE; Division of Engineering; Brown University; Providence, RI 02912]

MEDICAL TECHNOLOGY AND CRITICAL DECISIONS (1987)

An excellent course which serves an an introduction to Wellesley's Technology Studies Program. The course is designed to introduce students to the impact of modern medical technology on society, including both ethical and public policy issues. However, as part of the course, students are also introduced to modern diagnostic equipment, the scientific principles underlying modern medical technology, and statistical techniques. [TED DUCAS and JIM GRANT; Technology Studies Program; Wellesley College; Wellesley, MA 02181]

NUCLEAR TECHNOLOGY IN WAR AND PEACE: A STUDY OF ISSUES AND CHOICES (1987)

Course covers the history of nuclear energy and nuclear weapons, policy issues associated with nuclear technology, and the technology of nuclear power and nuclear weapons. More detailed syllabus published in **Bulletin of Science, Technology, and Society** 5 (1985): 369-384. [J. RICHARD SHANEBROOK; Mechanical Engineering Department; Union College; Schenectady, NJ 12308]

PHYSIOLOGICAL PSYCHOLOGY (1987)

Examines the physiology and anatomy of the human nervous system, focusing on the question of whether humans are machines. To answer that question the course also deals with the mind-body problem, cybernetics, information theory, systems analysis, and artificial intelligence. A well-designed course with a good reading list. [WAYNE D. NORMAN; Department of Psychology; Northwestern College; Orange City, IA 51041]

SOCIOTECHNICAL DESIGN CONCEPTS (1983)

A project-oriented course designed to teach non-engineers about technological planning and design concepts. [GERALD NADLER; Industrial Engineering Department; 447 Mechanical Engineering Building; University of Wisconsin; 1513 University Ave.; Madison, WI 53706]

STATISTICAL PROCESS CONTROL (1987)

A no prerequisite course designed to introduce students to the basics of statistical process control as applied in industry. [KAREN A. WELLS; Mississippi County Community College; Blytheville, AR 72315]

TAKING HOLD OF TECHNOLOGY (1987)

A self-paced study guide that focuses on understanding what technology is and its relationship with women's roles, with special sections focusing on energy, communications and information, appropriate technology, and modes of technology assessment. Now out of print. [AMERICAN ASSOCIATION OF UNIVERSITY WOMEN; 2401 Virginia Ave., N.W.; Washington, D.C. 20037]

TECHNICAL DEVELOPMENTS IN PRODUCTION (1987)

"A critical analysis of selected technical developments in production technology." Course includes a study of the principles, concepts, and processes fundamental to the emergence of these technical developments and how these technical developments impact society. [EDWARD C. PYTLIK; Technology Education Program; West Virginia University; Morgantown, WV 26506-6122]

C. Themes in Technology Studies

ALTERNATIVE FUTURES (1987)

A course which studies "alternative futures for individuals and societies and the use of forecasting techniques to determine probable futures." The course focuses on the relation of choices in technical systems to social purposes. [PAUL W. DEVORE, Technology Education Program; West Virginia University; Morgantown, WV 26506-6122]

ART, RELIGION AND TECHNOLOGY (1983)

"An interdisciplinary study of religious and aesthetic values as they have been affected by technological developments." [ERIKA WILSON and PETE SCHELLIN; California State University; 5151 State University Drive; Los Angeles, CA 90032]

BIOETHICAL ISSUES IN HUMAN REPRODUCTION (1987)

A quarter-length course focusing on the social and ethical issues surrounding scientific and technological developments in the area of human reproduction. Includes interesting readings and extensive study/exam questions. [THEODORE LOPUSHINSKY; Dept. of Natural Science; North Kedzie Laboratory; Michigan State University; East Lansing, MI 48824]

CHRISTIANITY IN A TECHNOLOGICAL SOCIETY (1987)

Course requires students to use media to prepare short reports on the impact of technology on society and to write a major report on the effect of technology on a local business. Instructor focuses on the "creationist tradition" in lectures. Complete syllabus published in **Science, Technology & Society**, no. 45 (Dec. 1984): 9-12. [CHRISTOPHER KAISER; Western Theological Seminary; Holland, MI 49423]

COMMUNICATION POLICY AND PLANNING: ALTERNATIVE PERSPECTIVES (1987)

Intended primarily for students planning to enter the field of communications. The focus is on alternative models in communications policy and planning, especially as they relate to differing cultures. Includes a detailed course outline and useful bibliography. [SARAH SANDERSON KING; Department of Communication; 1615 Stanley; Central Connecticut State University; New Britain, CT 06050]

COMMUNICATIONS TECHNOLOGIES AND CITIES (1987)

An in-depth look at communications technologies and their impact on urban development and function. Excellent selection of readings in the area. Topics covered include telecommunications policy, centralization and decentralization, technology in offices and organizations, cable television, public uses of information systems, etc. [MITCHELL MOSS; Graduate School of Public Administration; New York University; 4 Washington Square, North; New York, NY 10003]

COMPUTERS AND SOCIETY (1987)

A course focusing on the social impact of computers and related ethical issues. Topics include computer crime, privacy, employment and quality of work, computers and public policy, impact of computers on social structures and quality of life, the uses and limitations of artificial intelligence, computer ethics, and the special responsibilities of computer professionals. [PETER F. LIMPER; Christian Brothers College; 650 East Parkway South; Memphis, TN 38104]

ENERGY AND SOCIETY (1987)

An analysis of world energy resources and the problems associated with the retrieval and conversion of these resources into useful form. Also deals with problems of citizen awareness, responsibility, and public policy. [PAUL W. DEVORE; Technology Education Program; West Virginia University; Morgantown, WV 26506-6122]

GOVERNMENT AND THE MANAGEMENT OF TECHNOLOGY (1983)

This team-taught seminar "examines the changing role of government in shaping and directing the management of technology in the civilian sector of the economy." [GEORGE R. HEATON; HERBERT J. HOLLOMAN; NICHOLAS S. ASHFORD; and CHRISTOPHER T. HILL; Center for Policy Alternatives; Massachusetts Institute of Technology; W. 59-205, 201 Vassar St.; Cambridge, MA 02139]

MEDIA AND PROPAGANDA (1983)

An analysis of propaganda as related to technology both generally and in relationship to specific media. [PAUL LEVINSON; Communications, Speech and Theatre; Fairleigh Dickinson University; Teaneck, NJ 07666]

MINDS AND ROBOTS (1987)

Course uses discussions of possibility of building a thinking machine to review contemporary conceptions of mind, self, and consciousness, and the problems those conceptions pose. Complete syllabus published in **Science, Technology & Society**, no. 49 (Sept. 1985): 9-13. [STEVEN L. GOLDMAN; STS Program; Lehigh University; Bethlehem, PA 18015]

THE MORAL DILEMMA OF THE SCIENTIST (1983)

This quarter-length course seeks "insight into the complex, compelling character of the scientist as he/she is portrayed in modern dramatic literature. It attempts to deal with the scientist as he/she strives to know more of the world and is forced to consider the moral and philosophical implications of higher findings." Interesting readings could be utilized in a variety of non-literary courses. [ALLEN E. HYE; Modern Languages; Wright State University; Dayton, OH 45435]

NATIONAL SECURITY: ITS SCIENCE AND TECHNOLOGY (1987)

This one-semester course uses the issues surrounding national security to acquaint the student with broader questions of scientific methodology, its relationship to technology, and its social context. [AVROM A. BLUMBERG; Dept. of Chemistry; DePaul University; Chicago, IL 60614]

PHILOSOPHY OF TECHNOLOGY (1987)

Interdisciplinary, team-taught course (engineer and philosopher) in which students first attempt to define technology and its relationship to science and

engineering and then examine some of the more significant critiques and defenses of technology from a Christian perspective. [LAMBERT J. VAN POOLEN; Department of Engineering; Calvin College; Grand Rapids, MI 49506]

PHILOSOPHY OF TECHNOLOGY (1987)

Ten-week long course providing an overview of current controversies over the role of technology in society with emphasis on the philosophic assumptions and ideological images that underlie the dominant viewpoints. Instructor uses several innovative teaching methods. [PHILIP T. SHEPARD; Lyman Briggs School; Michigan State University; East Lansing, MI 48824-1107]

POLITICS AND THE TWENTY-FIRST CENTURY (1987)

This course explores the relationships of science and technology to politics and society, with a focus on the role politics plays in how science and technological systems are deployed in the interests of political and economic development. It addresses the implications of the transition from an industrial to a post-industrial/information era and possible political futures in a new and increasingly interdependent world community. [BENJAMIN HOURANI; Dept. of Political Science; Eastern Michigan University; Ypsilanti, MI 48197]

PRIMITIVE TECHNOLOGY (1983)

An anthropology course that seeks "to show how anthropologists can use technology as a point of view for the investigation of culture and human behavior in general." Includes an extensive supplementary bibliography. [PETER BLEED; Department of Anthropology; University of Nebraska; 121 Benton Hall; Lincoln, NE 68588-0619]

SCIENCE AND ETHICS (1987)

A team taught course with faculty from several disciplines dealing with case studies of important scientific and technological situations involving ethical issues, such as national security, the choice of energy, genetic engineering, human reproduction, and the allocation of limited health resources. [AVROM A. BLUMBERG; Department of Chemistry; 1036 W. Belden Ave.; DePaul University; Chicago, IL 60614]

SCIENCE AND TECHNOLOGY IN THE POST-WAR ERA (1983)

An introduction to the development of science and technology in the Federal Republic of Germany since World War II. Included are problems of European policy coordination, the dilemmas of the scientist, and science policy in other countries and economic systems. Topics and most readings are in German. [DAVID C. CASSIDY; Universitat Regensburg; D-8400 Regensburg; West Germany]

SCIENCE, TECHNOLOGY AND HUMAN VALUES (1983)

A philosophy course for non-philosophers focusing on recent attempts to understand and evaluate the role of technology in society. Reprinted in full in **The Machine in the University**, first ed., pp. 145-152. [MARTIN CURD; Department of Philosophy; Purdue University; West Lafayette, IN 47907]

SCIENCE, TECHNOLOGY AND POLITICS (1983)

The influence of science and technology on contemporary politics is the theme of this upper-level seminar designed for non-majors. Utilizes both lecture and discussion. Solid reading assignments. [P.W. HAMLETT; Dept. of Political Science; University of Missouri-Rolla; Rolla, MO 65401]

SCIENCE, TECHNOLOGY, AND PUBLIC POLICY (1983)

Historical relationships between government, science, and technology; organization for science policy in major governments; political, administrative, and technical procedures through which public policy on science and technology is formulated. Reprinted in full in **The Machine in the University**, first ed., pp. 165-171. [LYNTON K. CALDWELL and ROBERT V. BARTLETT; Department of Political Science and School of Public and Environmental Affairs; Indiana University; Bloomington, IN 47401]

SCIENCE/TECHNOLOGY AND PUBLIC POLICY (1983)

This political science seminar analyzes the public policy-making process as it relates to science and technology questions on the state, national, and international levels. An in-depth research paper and class presentation from each student are major components of the course. [EDWARD CHASZAR; Political Science Dept.; Indiana University of Pennsylvania; Indiana, PA 15701]

TECHNOLOGICAL CHANGE AND URBAN POLICY (1983)

Public policy and technological change are examined in the urban context, especially as they are related to communications technology. Useful readings. [MITCHELL MOSS; Graduate School of Public Administration; New York University; 4 Washington Square, North; New York, NY 10003]

TECHNOLOGY AND COMMUNITY DEVELOPMENT (1987)

A seminar course exploring the relationships between social purpose, community development, and technological means. [PAUL W. DEVORE; Technology Education Program; West Virginia University; Morgantown, WV 26506-6122]

TECHNOLOGY AND ENVIRONMENT (1987)

Course deals with human interaction with the natural environment, particularly the impact of technology and the technological/environmental choices of the future. [PAUL W. DEVORE; Technology Education Program; West Virginia University; Morgantown, WV 26506-6122]

TECHNOLOGY AND HUMAN BEHAVIOR (1987)

An interdisciplinary course focusing on the ways in which technology influences personal interaction. Emphasis is placed on how the physical, intellectual, psychological, and social development of individuals, and the society in which they find themselves, can be affected by technology. Among the specific topics examined are the influence of the built-environment, electronic communications (including TV and computer), the automobile revolution, ethical issues in the delivery of health care, and technology in the workplace. [MICHAEL L. BERGER; St. May's College of Maryland; St. Mary's City, MD 20686]

TECHNOLOGY AND HUMAN VALUES (1987)

Discussion-lecture course focusing on three themes: (1) attitudes towards technology, (2) the engineer and society, and (3) society and technology. Underlying goal is to give students an understanding that technology is a social process and that "the social impact of technological innovation is primarily an expression of how a society channels the work of scientists and engineers through institutions characteristic of that society." Earlier version reprinted in full in **The Machine in the University**, first ed., pp. 153-155. [STEVEN L. GOLDMAN; STS Program; Lehigh University; Bethlehem, PA 18015]

TECHNOLOGY AND SOCIETY IN THE THIRD WORLD (1987)

Quarter-length course deals with encounters between Third World societies and technologically-sophisticated industrial societies, examining the social and political implications of the transfer of technology to a variety of Third World societies. [SALLY E. MERRY; Department of Anthropology; Wellesley College; Wellesley, MA 02181]

TECHNOLOGY ASSESSMENT (1987)

A graduate-level course which requires chemistry students to learn the process of carrying out technology assessments and which requires them to do one. Described in **Journal of Chemical Education** 63 (1986): 522-525. [NANCY J. SELL; ES 317; University of Wisconsin-Green Bay; Green Bay, WI 54302]

TECHNOLOGY: INTERNATIONAL, SOCIAL, AND HUMAN ASPECTS (1987)

Undergraduate, team-taught course which examines the mutual interactions between technology and its users. The first third of the course concentrations on interrelationships between technology, the environment, and the socioculture within the U.S.; the second third examines comparable relationships in non-Western societies and the difficulties of technology transfer. In the last third of the course students are assigned hypothetical proposals for technology transfer and are asked to identify the environmental and sociocultural factors that would affect the success of the transfer. [KARL E. GWIASDA; Technology and Social Change Program; Iowa State University; Ames, IA 50011]

VALUES AND ETHICS IN SCIENCE AND TECHNOLOGY (1983)

Deals with historical and current attitudes toward technology, the nature of ethics, professional ethics, ethical dilemmas faced by scientists and engineers, values in a technological society, etc. Good reading list. Reprinted in full in **The Machine in the University**, first ed., pp. 157-163. [CARL BARUS and PATRICIA SPRINGBORG; Department of Engineering, Department of Philosophy; Swarthmore College; Swarthmore, PA 19081]

WOMEN AND TECHNOLOGY (1987)

An interdisciplinary course to familiarize students with past and present concepts of technology as related to women's issues, to probe the nature and origin of the problems women face in becoming decision-makers in a technological society, and to give students an overview of women in modern technical professions. Complete syllabus published in **Science, Technology & Society**, no. 39 (Dec. 1983): 13-18. [ALEXANDRA ALDRIDGE; Eastern Michigan University; Ypsilanti, MI 48197]

THE END